Reciprocating Engines. Turbine Engines.

Superheaters. ✻ Condensers.

Hydraulic Lifts.

Hydraulic Pumps. Hydraulic Gearing.

ENGINEERING EMPLOYERS' FEDERATION 1896

ON ADMIRALTY LIST.

COOPER & GREIG,

ENGINEERS,

BOILERMAKERS and IRONFOUNDERS,

∴ DUNDEE. ∴

SCOTLAND.

CONTRACTORS TO H.M. GOVERNMENT.

Water Tube Boilers. Return Tube Boilers.

Lancashire and Cornish Boilers.

Vertical Boilers. Locomotive Boilers.

TELEPHONE 566. TELEGRAMS: "CONDENSER, DUNDEE."

Reciprocating Engines. Turbine Engines.

Superheaters. ✻ Condensers.

Hydraulic Lifts.

Hydraulic Pumps. Hydraulic Gearing.

ENGINEERING EMPLOYERS' FEDERATION 1896

ON ADMIRALTY LIST.

COOPER & GREIG,

ENGINEERS,

BOILERMAKERS and IRONFOUNDERS,

.·. DUNDEE. .·.

SCOTLAND.

CONTRACTORS TO H.M. GOVERNMENT.

Water Tube Boilers. Return Tube Boilers.

Lancashire and Cornish Boilers.

Vertical Boilers. Locomotive Boilers.

TELEPHONE 566. TELEGRAMS: "CONDENSER, DUNDEE."

LIST OF ILLUSTRATIONS.

Horizontal Reciprocating Engine, ... 5
Corliss Valve Motion, ... 6
Tandem Corliss Engine, ... 7
Compound Corliss Mill Engine, ... 8
Triple Marine Engine, ... 8
2000/3000 H.P. Compound Inverted Vertical Mill Engine, ... 9
Upper and Second Platform of do. do. 10
Exhausters for Gas Stations, ... 11
Tandem Side-by-Side Compound Condensing Mill Engines, ... 12
2000/3000 I.H.P. Triple Expansion Engine, ... 13
900 H.P. Triple Marine Engine, ... 14
1200 I.H.P. Triple Marine Engine, ... 15
1600 I.H.P. Twin Screw Triple Engines, ... 16
Compound Twin Screw Engines, ... 17, 18
Triple Expansion Marine Engines, ... 19
High-Pressure Marine Boilers,... 20
High-Pressure Four Furnace Marine Boiler, ... 21
High-Pressure Lancashire Boiler, ... 22
Buoys for River Service, ... 23
Hydraulic Stokers, ... 24
Superheaters, ... 25, 26
Steam Turbines, ... 27 to 35
High-Pressure Rotor with Blading Exposed, ... 29
Side Elevation and Cross Section of Rotor Blading and Diaphragms, ... 30
High-Pressure Cylinder with Diaphragms in Position, ... 31
Cooper Patent Complete Expansion Turbine, ... 32
Mixed Pressure Turbine with Condensing Plant and Electric Generator, ... 33
Application of Reduction Gear to Turbine with Rope Drum, ... 34
Cooper Patent Mixed Pressure Turbine, ... 35
Evaporative Condensers in Separate Narrow Tanks, ... 36, 51
Evaporative Condenser in Large Single Tank, ... 37
Barometric Condenser Head, ... 38
Triple Hydraulic Engine and Gearing, ... 39
Bridges for Crossing Dock Entrances, ... 40
Exhaust Steam Feed Water Heater, ... 41
Exhaust Steam Water Heater, ... 42
Live Steam Feed Water Heater, ... 43
Filter, ... 44
Oil Separator, ... 45
Evaporator, ... 46
Long Stroke Feed Pump, ... 47
Ballast Pump, ... 48
Thermo Circulators, ... 49, 51
Compound Marine Engine for Whaling Vessels, ... 50
50 Ton Lift Steam Derrick Crane, ... 50
Horizontal Corliss Tandem Compound Mill Engine, ... 50
High-Pressure Compound Semi-Portable Engine for Sawmills, ... 50
High-Pressure Lancashire Boiler, ... 50

WE have catalogued several illustrations showing some of the different types of Plant supplied to local and other firms and all built at our Works. We are makers of RECIPROCATING ENGINES, STEAM TURBINES, STEAM PUMPS, EVAPORATIVE CONDENSERS, SURFACE CONDENSERS, JET CONDENSERS, AIR AND CIRCULATING PUMPS, HYDRAULIC ENGINES, GEARING, SHAFTING, BOILERS for Land or Marine service, SUPERHEATERS, HEATERS, FURNACES, &c.

Steam Engines and Boilers form the most economical and pliable source of power we have, more especially for the delivery of large powers; and where a complete plant has been put down there is nothing to equal steam for steady running and reliability, starting under full load, &c. Gas Engines and Oil Engines are good and serviceable, and very economical under suitable conditions, but neither can start under load nor run with the steadiness or continuity of the steam engine.

The weight of fuel for a good steam plant per B.H.P. per hour runs from $1\frac{1}{4}$ lbs. to 1 lb. and under. With coal at 10/- per ton, 18·5 B.H.P. would cost one penny per hour.

Suction Gas Engines cannot start under a load, as they have no power to draw upon, but must compress gas fuel before a power stroke can be made. This is provided for in using a storage of compressed air, &c., to get the fly-wheel into motion, when the first power stroke may then be made. Very heavy fly-wheels and crank shafts are required for a fair measure of steadiness and safety. The water required for gas making, cooling, and scrubbing the gas is fully as much as that required for make-up feed for a good steam plant. About ·9 of a lb. of anthracite coal at 25/- per ton would give $8\frac{1}{2}$ B.H.P. for one penny per hour.

Oil Engines have similar difficulties to contend with as the Gas Engine, but for some purposes are very convenient. The cylinder pressures which must be used are much higher than any other type of Gas Engine, but good economy is obtained in this way from the oil fuel. The high initial pressure requires heavy parts and heavy fly-wheels or many cylinders and quick revolutions to keep down weights.

The oil required per B.H.P. per hour runs from ·5 lbs. to ·4 lbs. or under for the high compression type, and ·7 lbs. and over for the low compression system. Taking oil at 50/- per ton, ·4 lbs. per B.H.P. would equal $9\frac{1}{2}$ B.H.P. per hour for one penny. With the low compression at ·7 lbs. per B.H.P., $5\frac{1}{2}$ B.H.P. would cost one penny per hour. That is to say:

With Condensing Engines of best class,	18·5	B.H.P.	will cost	One	Penny	per Hour.
,, Steam Turbines, - -	18·5	B.H.P.	do.	do.	do.	For Fuels at average Prices.
,, Suction Gas Engines, -	$8\frac{1}{2}$·0	B.H.P.	do.	do.	do.	
,, Do. do., using coke,	$9\frac{1}{2}$	B.H.P.	do.	do.	do.	
,, Oil Engines, using low compression,	$5\frac{1}{2}$	B.H.P.	do.	do.	do.	
,, Do. do. high do.,	$9\frac{1}{2}$	B.H.P.	do.	do.	do.	

As mentioned, the water required for Suction Gas Plant is fully equal to that required for good Steam Engines, but for Oil Engines a very small amount of water is utilised, as in these it is only used for cooling power cylinders. Where the Suction Gas Plant has been adapted to make gas from spent materials a greater economy in gas power cost results.

We are at all times pleased to advise in regard to the best system of power plant which should be adopted for new works or where alterations are under consideration, and will be pleased to quote for Steam, Gas, or Oil plant, as may be found desirable.

COOPER & GREIG,

ENGINEERS AND BOILERMAKERS, DUNDEE.

LAND ENGINES.

We supply Land Engines suited for the use of saturated or superheated steam, Single Cylinder Expansion, Compound, or Triple Expansion, built as Horizontal Side-by-Side or Inverted Vertical. We also supply Steam Turbine Engines for any service.

The details of construction, such as valve gear, shafting, framing, flywheel, pistons, rods, pumps, &c., are arranged to suit the duty, whether for direct coupling, or Mill driving by ropes, belts, or gearing.

CONDENSING PLANT.

We supply Surface Condensers, Evaporative Condensers, Barometric Condensers, also Jet Spray Coolers, Tower Coolers, and Open Stack Coolers, Circulating Pumps, Air Pumps, Force Pumps, Feed Pumps, &c. &c.

Feed Heaters, Evaporators, Filters, Oil Separators, Superheaters, Air Heaters, Forced Draft Fans, Mechanical Furnaces, &c. &c., including all the necessary auxiliaries required to complete the most economical working Steam Plant.

STEAM GENERATORS.

Boilers of all descriptions, Marine Return Tube, Locomotive, Water Tube, Lancashire, Upright, including all auxiliaries, also Tanks, Buoys, and Steel Bridges of moderate span, &c. &c.

MARINE MACHINERY.

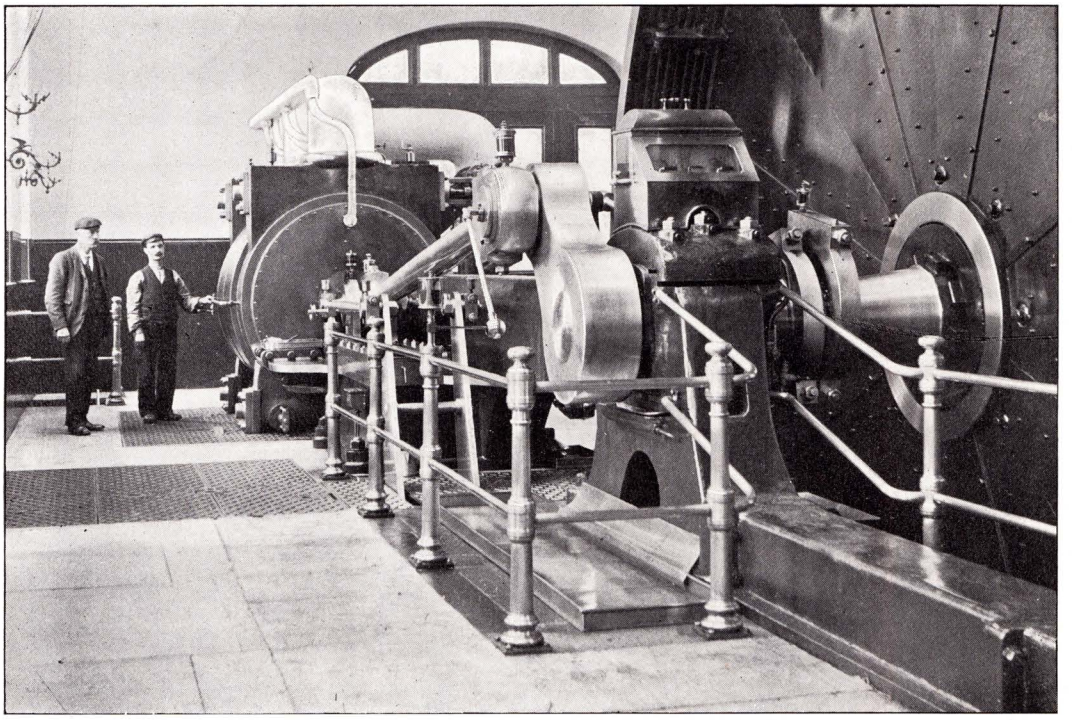
Machinery for Screw-propelled Vessels, and also for Paddle Vessels, Compound or Triple Expansion, with saturated or superheated steam ; also Deck Machinery, Propellers in Bronze, Steel, or in special mixture of tough Cast Iron ; Paddle Wheels with steel or wood feathering floats, &c. &c.

We are glad to correspond at any time where work is being considered either for Land or Marine Service, and will be glad to furnish Plans and Estimates for any Complete Plant.

COOPER & GREIG,

ENGINEERS AND BOILERMAKERS,

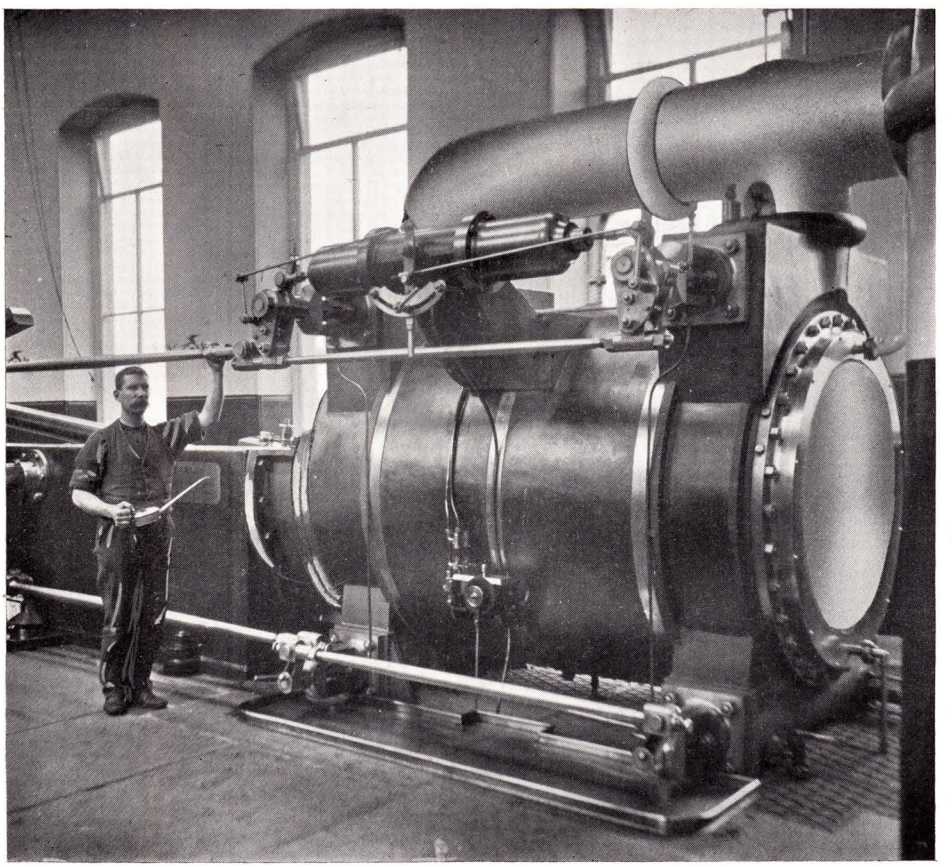
DUNDEE, SCOTLAND.



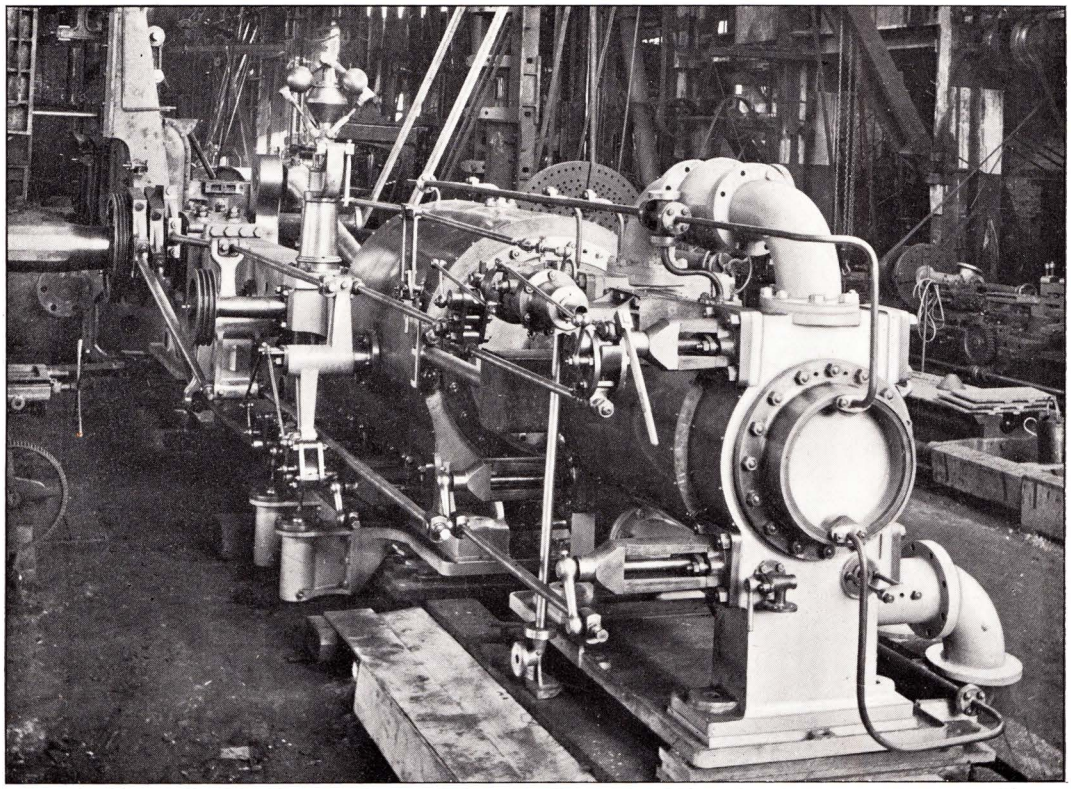
STANDARD TYPE OF HORIZONTAL RECIPROCATING ENGINE for Mill Driving, constructed with Corliss Valves, Piston Valves, Double-beat Drop Valves or ordinary Slides as may be required for service.

Suitable for Paper Mills, Rice Mills, Jute Mills, Oil Mills, Cotton Mills, &c.

For quotation purposes please say I.H.P. required, steam pressure, revolutions, and whether for rope, belt, or gear driving.

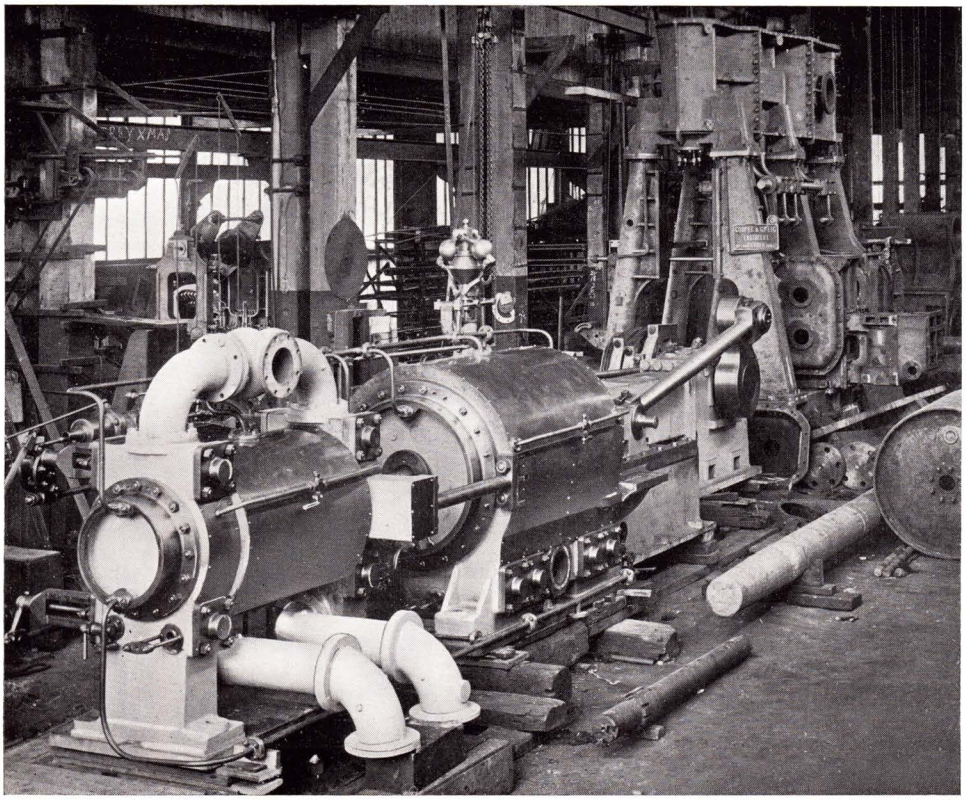


STANDARD TYPE OF CORLISS VALVE MOTION for L.P. Steam and Exhaust Valves.



STANDARD TYPE OF TANDEM CORLISS ENGINE
(During construction in our Works).

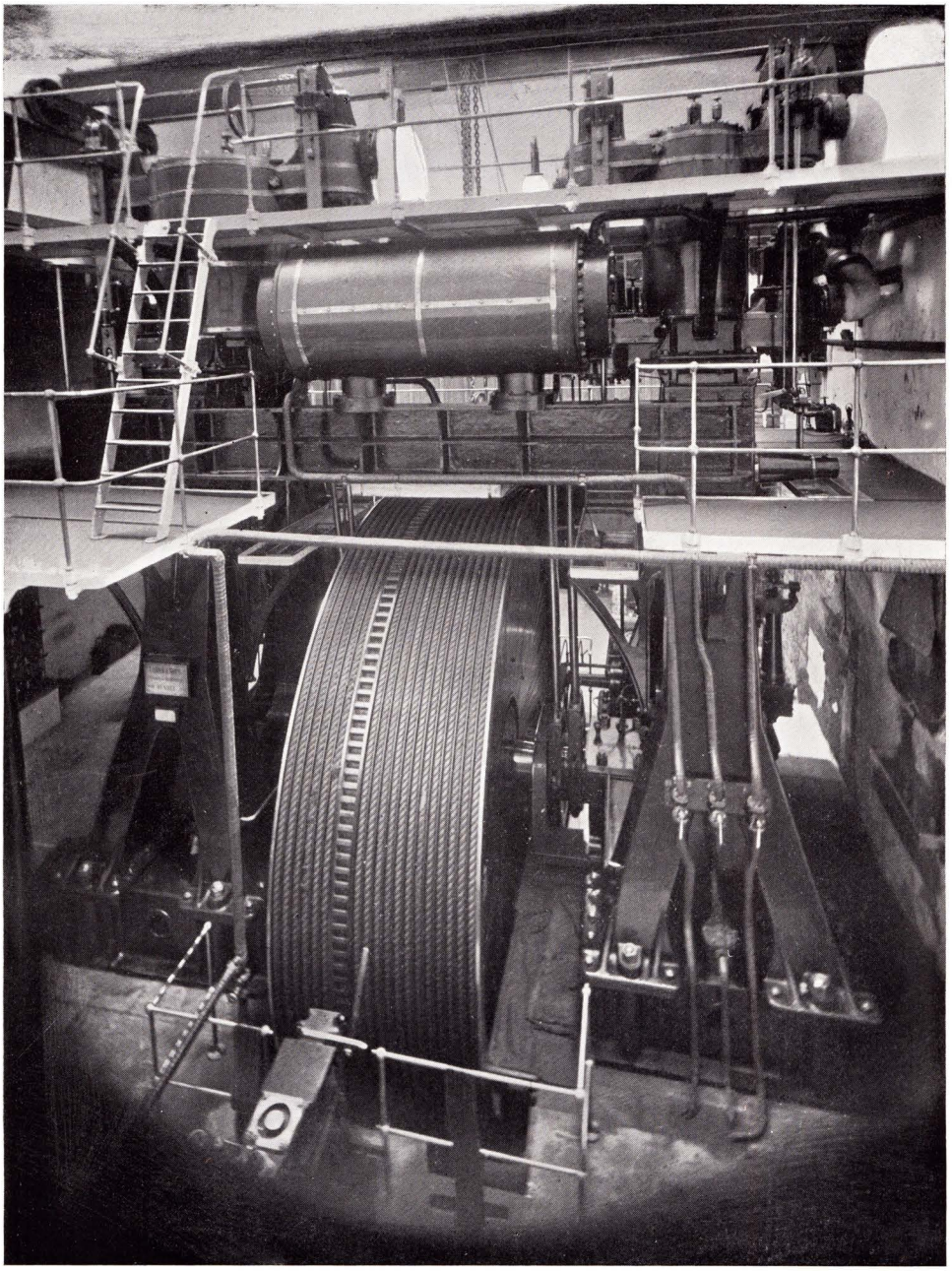
These Engines, using superheated steam and fitted with double beat valves, use 10 lb. to 12 lb. of steam per I.H.P. per hour ; boiler pressure 150 lb. to 160 lb. Engines running at normal speed and loads, vacuum 26/27 inches. Pistons are carried upon special white bronze shoes moving upon lower portion of cylinder barrel, or by separate tail rod to carry weight of piston off barrel when a high superheat is used to obtain greater steam economy.



COMPOUND CORLISS MILL ENGINE and TRIPLE MARINE ENGINE, being completed in Shops.

Trunk framing carried to foundations. Crosshead, guides, connecting rod, piston rod, and gland, &c., readily examined.

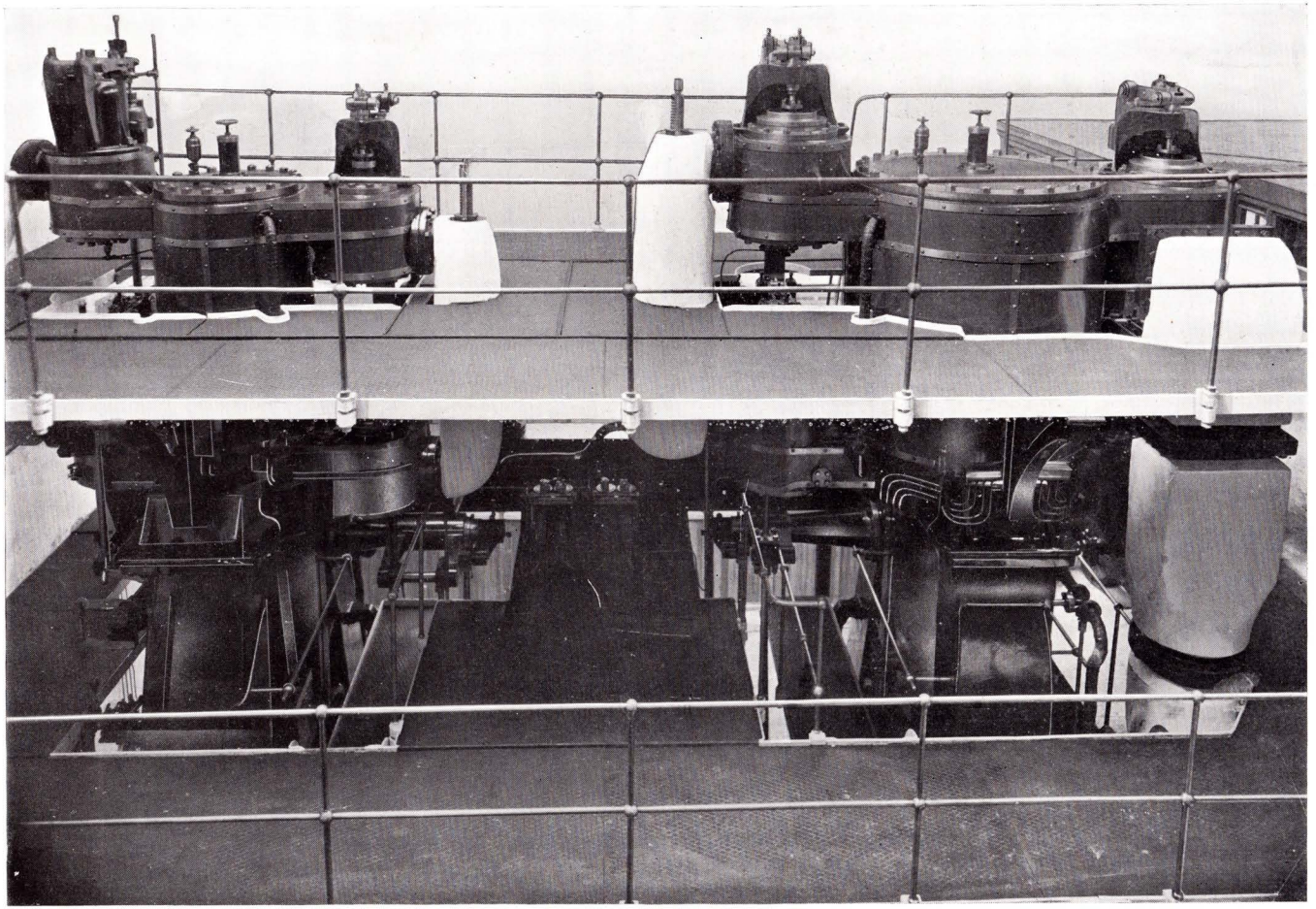
For quotation purposes please say I.H.P. required, steam pressure revolutions, and whether for rope, belt, or gear driving.



2000/3000 H.P. COMPOUND INVERTED VERTICAL MILL ENGINE, with double beat valves, &c., suitable for superheated steam, automatic regulating gear, steam turning gear, surface or jet condensing.

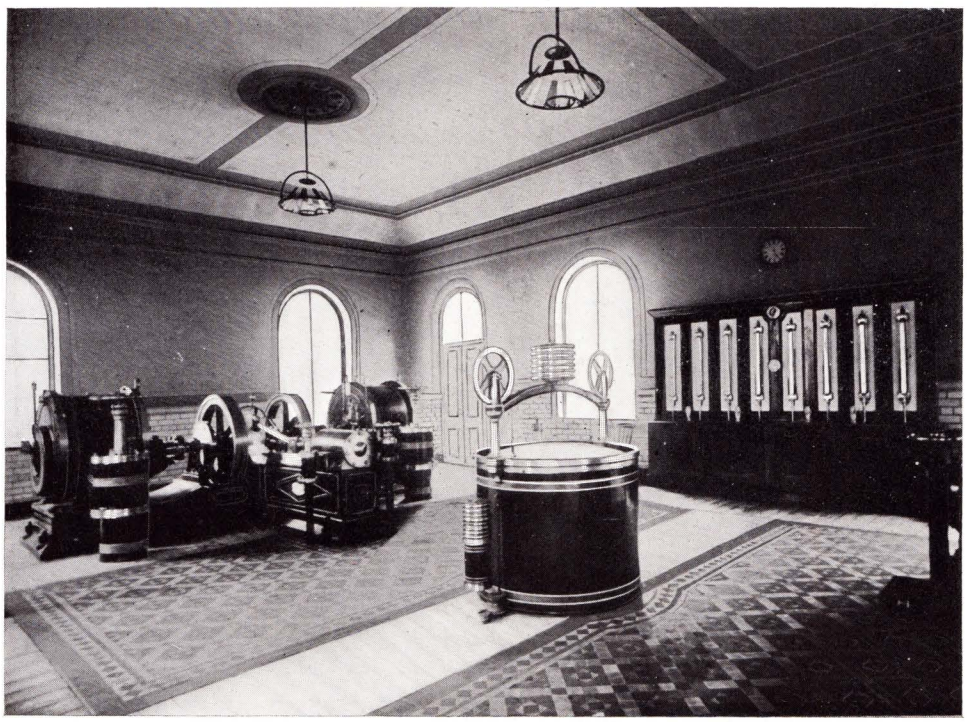
Suitable for Paper Mills, Rice Mills, Jute Mills, Oil Mills, Cotton Mills, &c.

For quotation purposes please say I.H.P. required, steam pressure revolutions, and whefher for rope, belt, or gear driving.



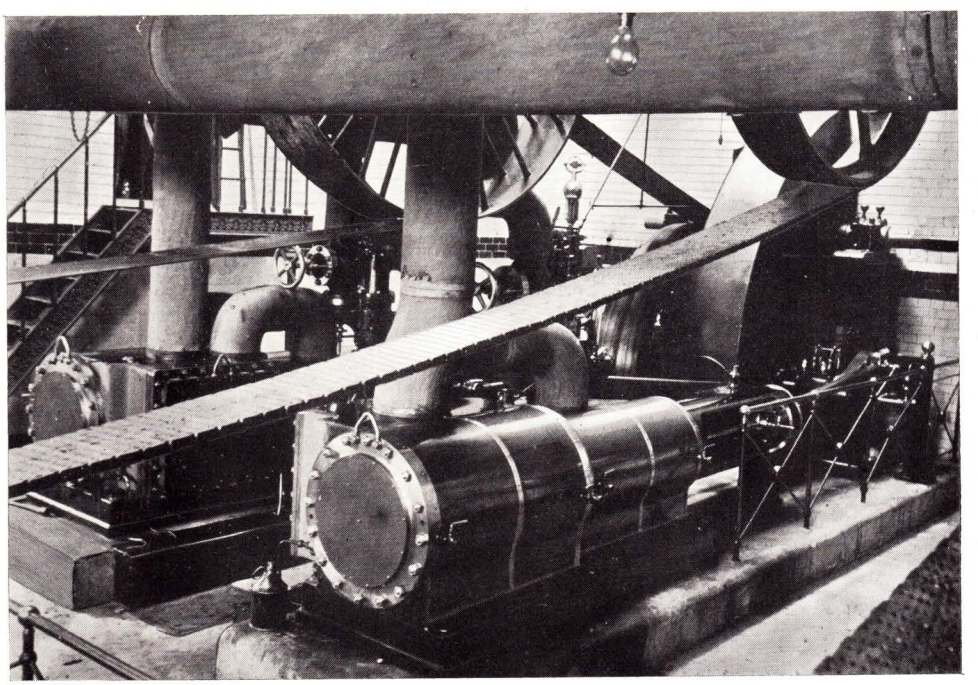
UPPER AND SECOND PLATFORMS OF VERTICAL MILL ENGINE, SHOWING VALVE ARRANGEMENTS.

The Speed Control with double beat valve is very perfect, as there is practically no resistance to regulating gear.



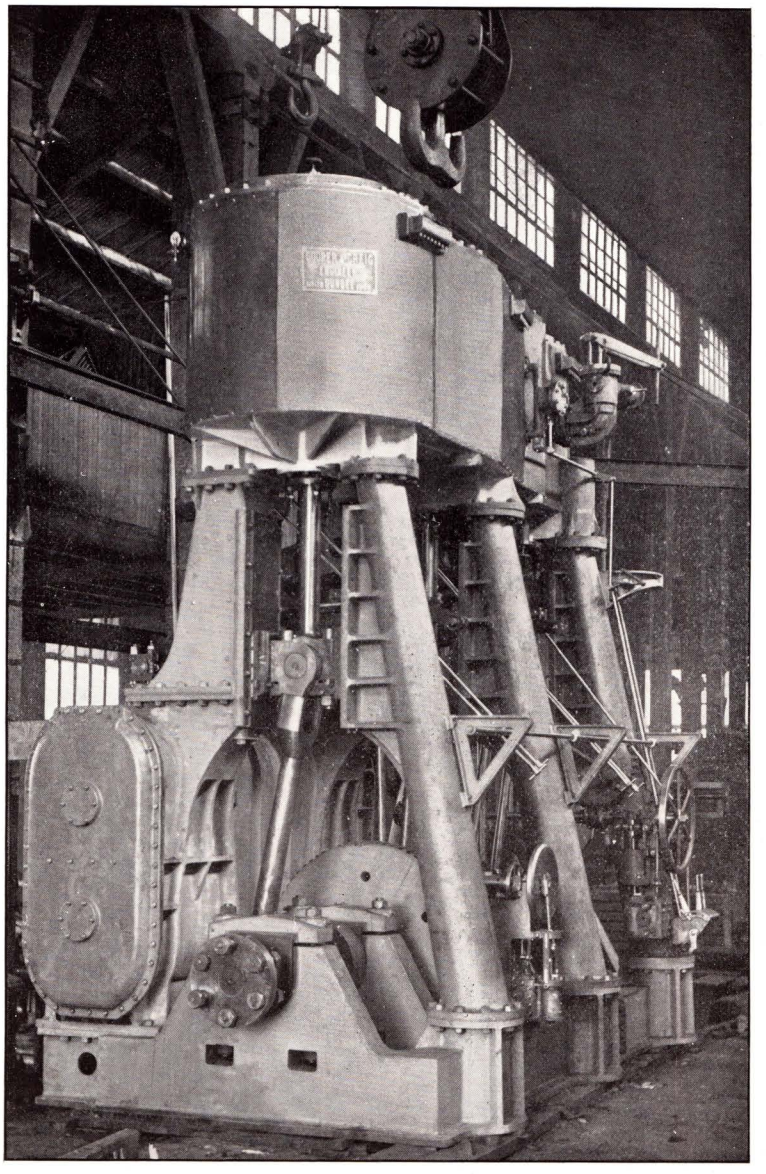
EXHAUSTERS COUPLED WITH STEAM ENGINE FOR GAS STATIONS.

Gas Exhausters and Coupled Engines for reducing pressure upon one set of mains and apparatus, while assisting with a slight pressure upon the other side to reduce load and frictional resistance.



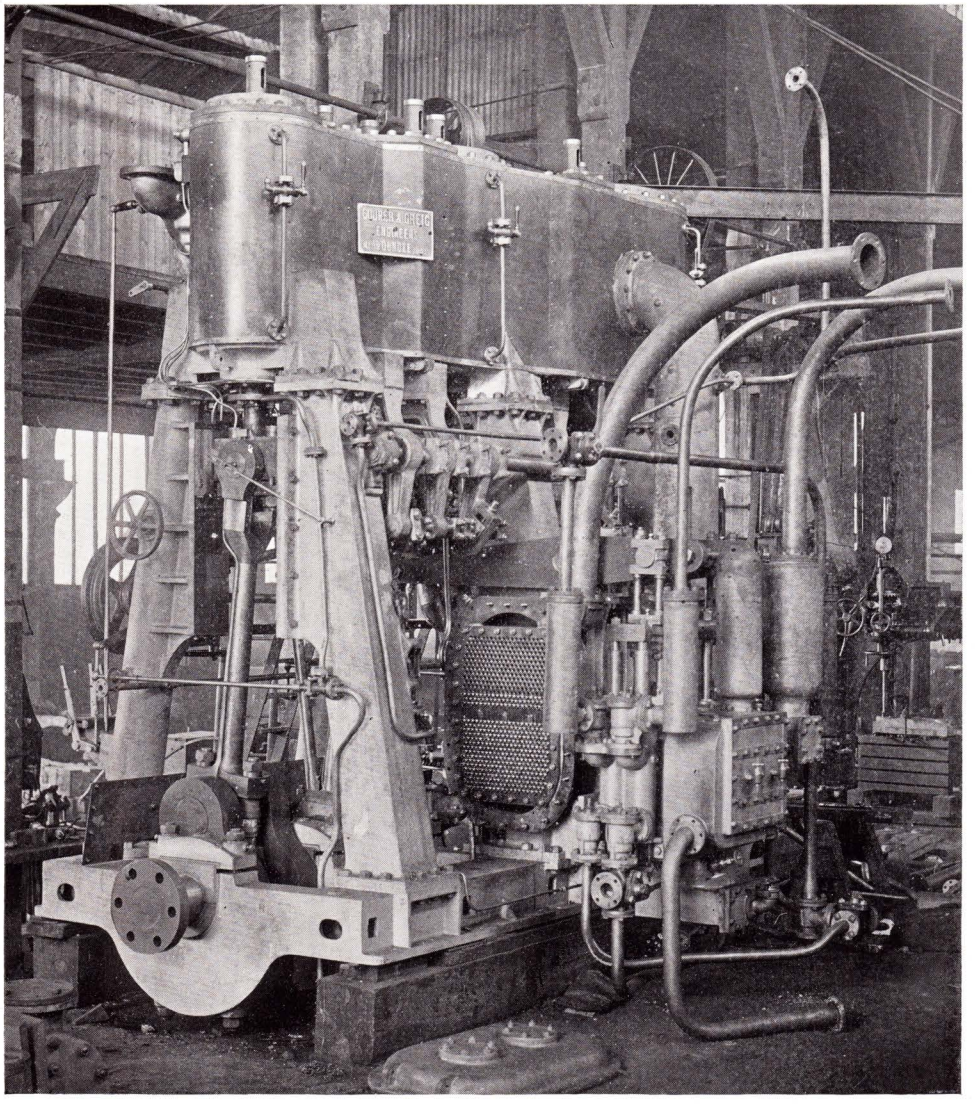
TANDEM SIDE BY SIDE COMPOUND CONDENSING MILL ENGINES.

Tandem Compound Mill Engines can be fitted where very steady driving is required, as governor adjusts automatic cut-off valves upon both Engines at same time. These Engines have a gear drive to shaft in front for mill shaft, and also a heavy belt drive backward for driving electric generators.

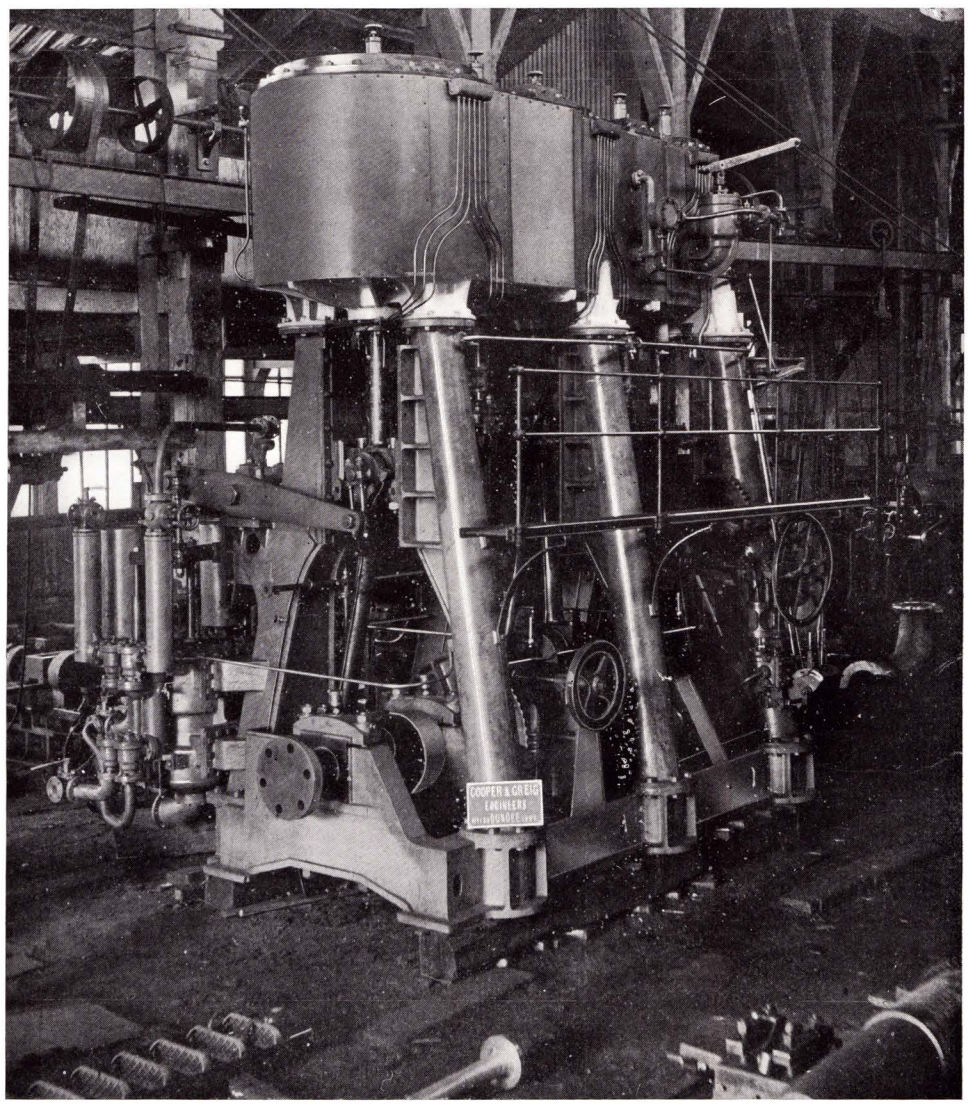


2000/3000 I.H.P. TRIPLE EXPANSION ENGINES, with Piston or Slide Valves, &c., suitable for any pressure up to 200 lbs. and superheat to 600 degrees ; lowest steam consumpt per H.P.

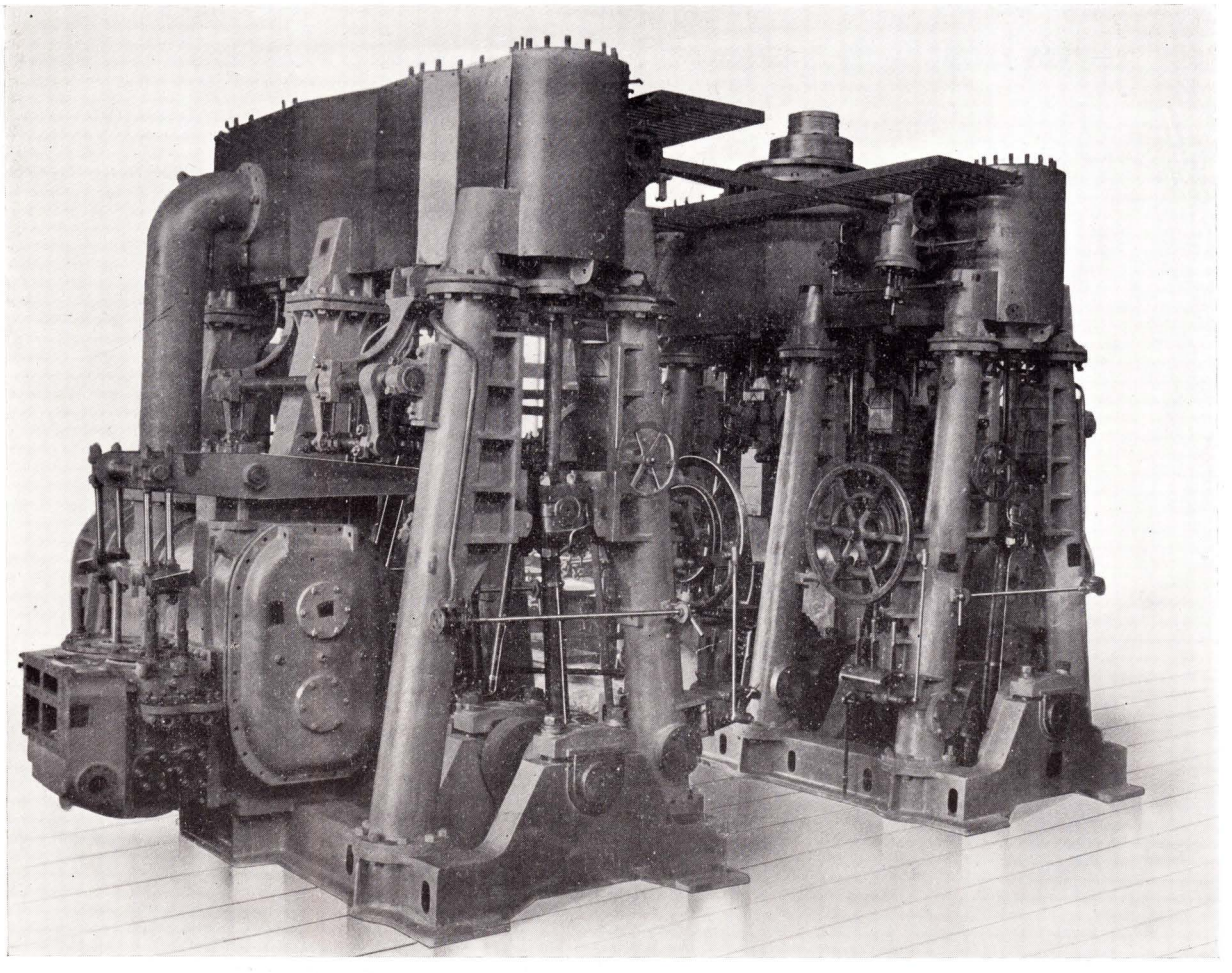
Suited for Passenger or Cargo Vessels, Mill driving, &c.



900 H.P. TRIPLE MARINE ENGINE being completed and fitted with Copper Piping in shops.



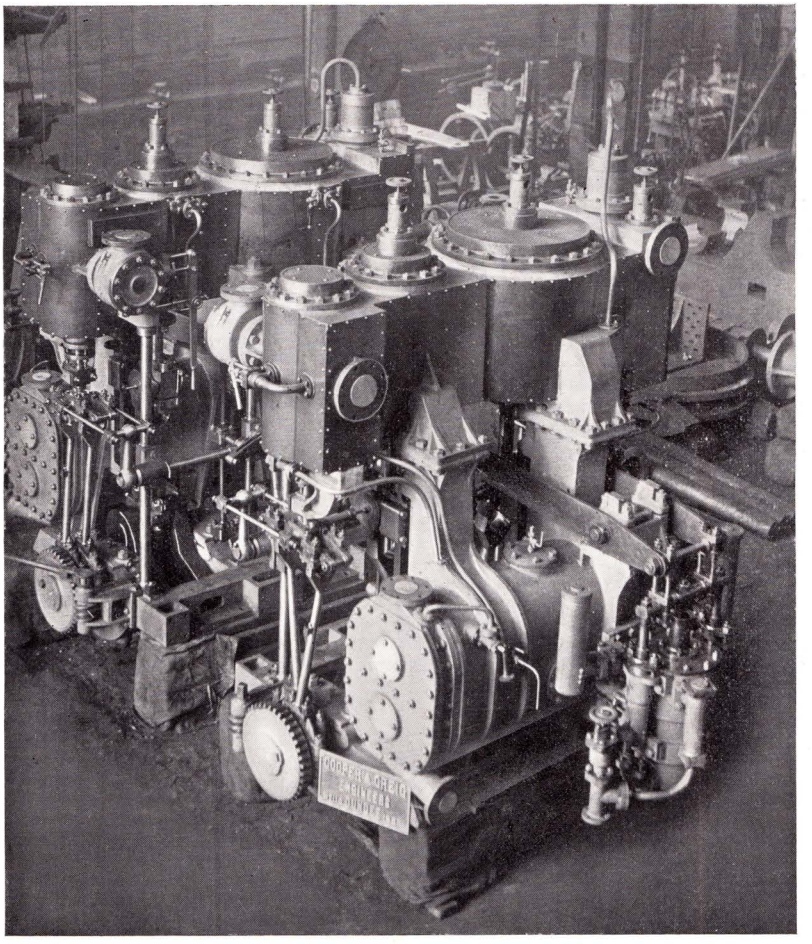
1200 I.H.P. TRIPLE MARINE ENGINE nearing completion in Shops.



1600 I.H.P. TWIN SCREW TRIPLE ENGINES being completed in Shops.

COOPER & GREIG,

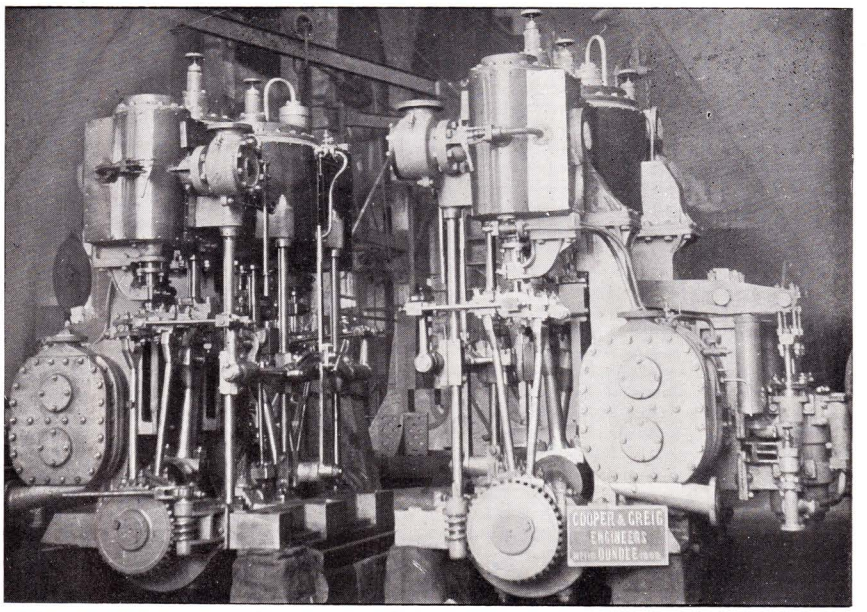
Engineers, DUNDEE.



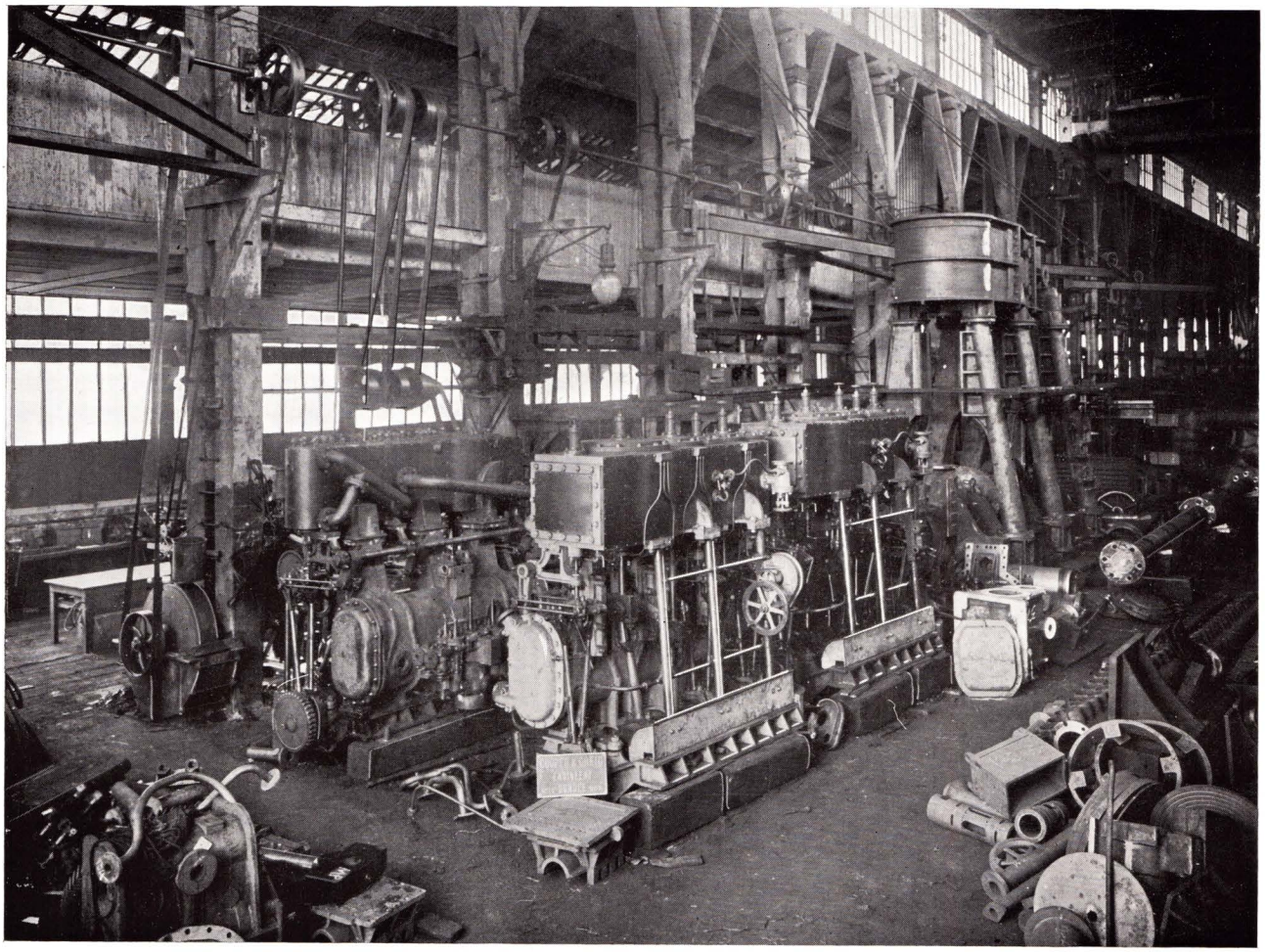
COMPOUND TWIN SCREW ENGINES for Quick Revolution High-speed Passenger Vessel. Fitted with Piston Valves for H.P. and Balanced Slide for L.P., Quick Action Reversing Gear, Centrifugal Circulating Pump, &c.

COOPER & GREIG,

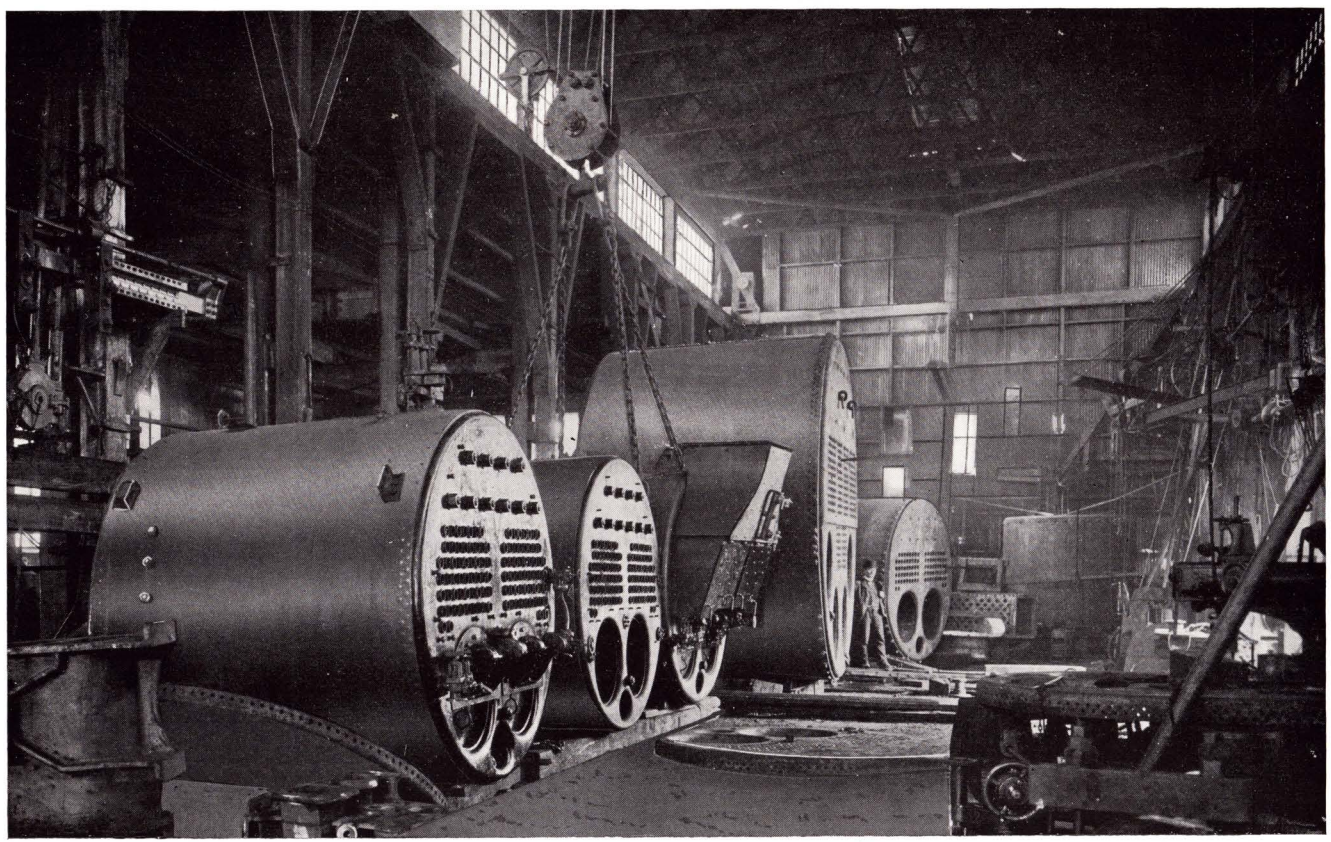
Engineers, DUNDEE.



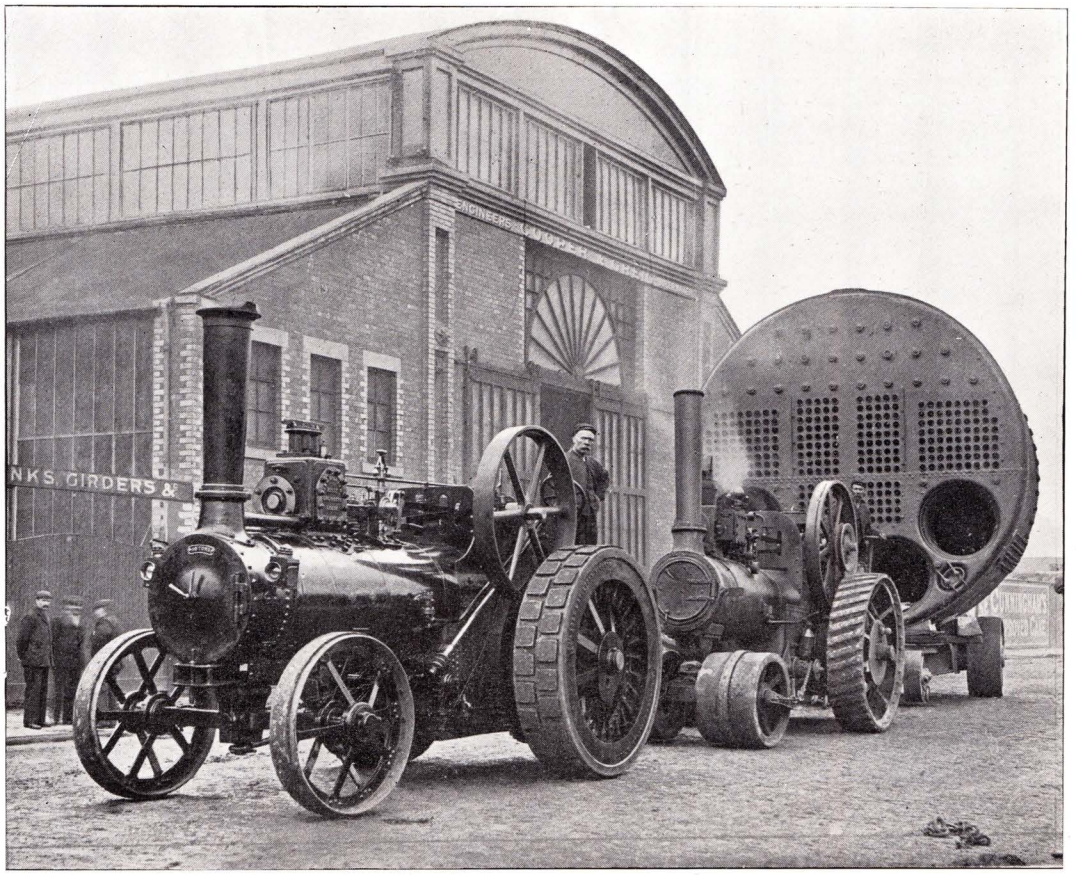
COMPOUND TWIN SCREW ENGINES for Passenger Vessel.



A NUMBER OF TRIPLE EXPANSION MARINE ENGINES being completed.

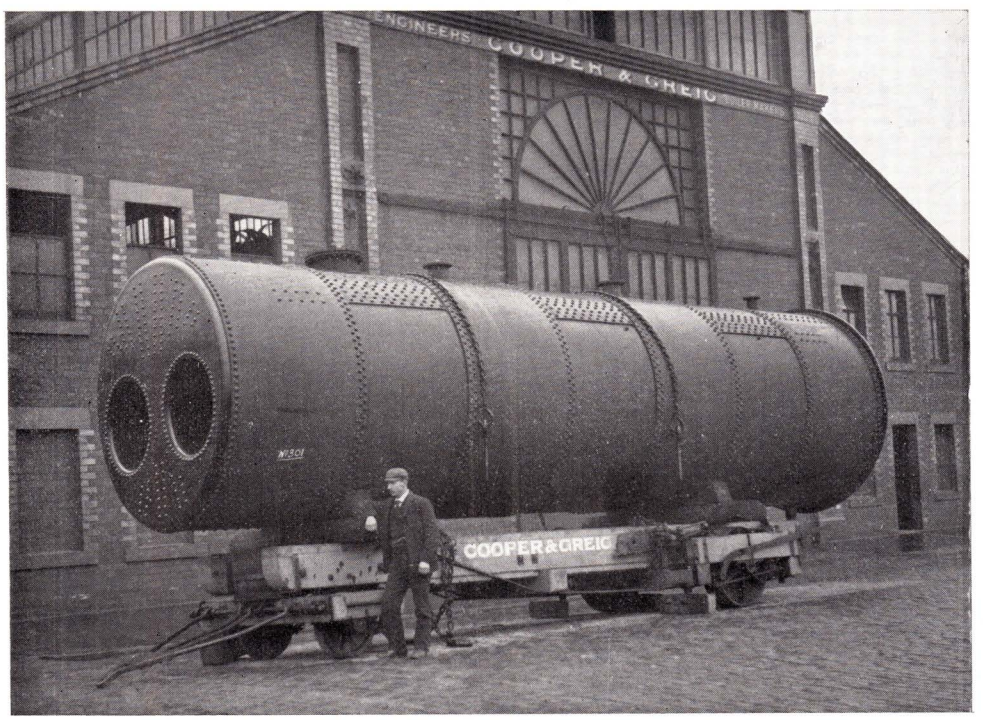


CORNER OF BOILER SHOP with HIGH-PRESSURE MARINE BOILERS in different stages of construction.



HIGH-PRESSURE FOUR FURNACE MARINE BOILER.

We make Return Tube Boilers in Steel, with furnaces either corrugated or plain, and for working pressures up to 200 lb. or over, to pass Board of Trade, Admiralty, or Lloyds' Survey, &c. These Boilers are usually fitted on board vessels, but we have fitted them ashore where space was not available for Lancashire or other Boilers. They are more expensive, but very economical steam raisers. The Boiler illustrated weighs about 60 tons, and is suited for 180 lb. working pressure, diameter over 16 feet.



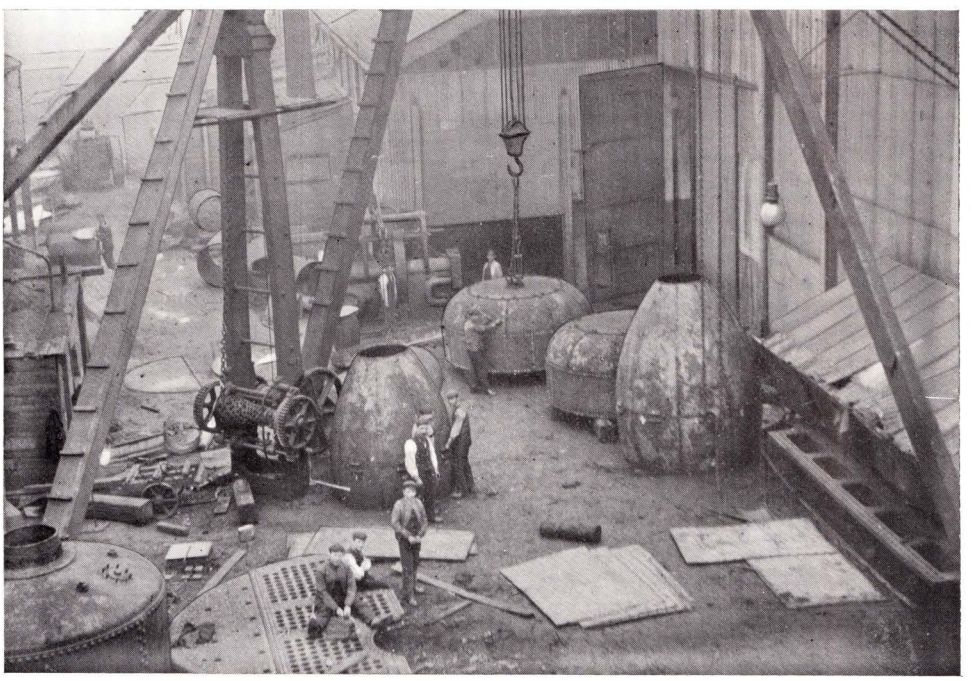
HIGH-PRESSURE LANCASHIRE BOILER.

The Lancashire Boiler still retains the position of a good and economical steam producer, and has special advantages in being readily got into for cleaning should feed water contain an objectionable amount of sediment or oil. If sediment or oil is allowed into Boilers overheating may damage furnaces, and more coal is used to evaporate water. These Boilers are made with flanged furnaces and flues, also flanged back end, all flues being welded in short lengths and flanged by special machinery. Rivet holes drilled by machinery, and all riveting done by hydraulic power where practicable. Plate edges planed, and caulking done by pneumatic tools. These Boilers can be made in any size or pressure up to 200 lb.

Suitable for Paper Mills, Rice Mills, Jute Mills, Oil Mills, Cotton Mills, &c.

COOPER & GREIG,

Engineers, DUNDEE.

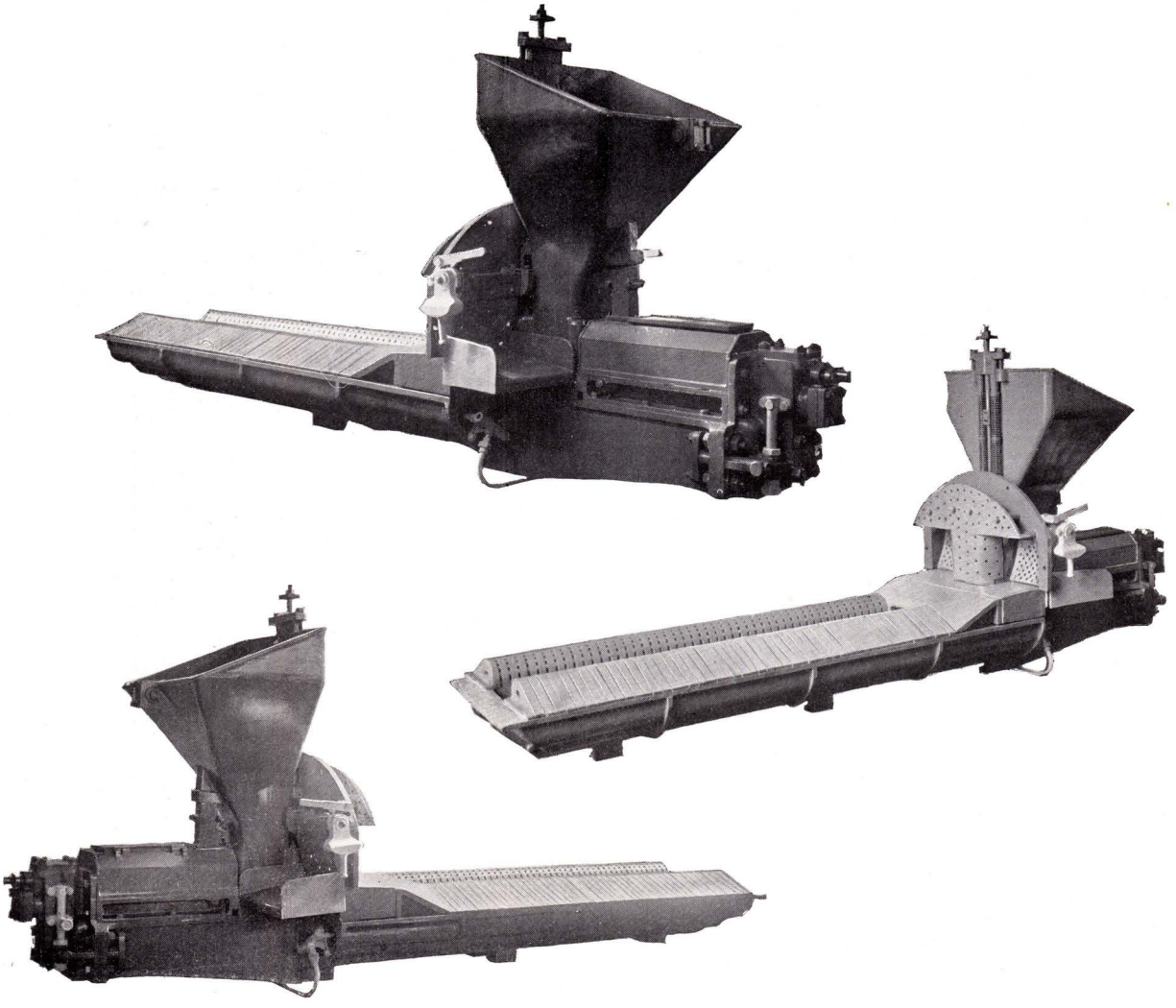


BUOYS FOR RIVER SERVICE—LIGHTING, ELECTRICAL CABLES, &c.

Floating Buoys for lighting rivers, or service in laying down Electric Cables, &c., are made in steel, of any shape or size to suit requirements, and fitted with the latest automatic lighting apparatus. For quotation purposes please send outline sketch showing shape and dimensions, &c., as there are so many different sizes and particulars for different situations.

COOPER & GREIG,

Engineers, DUNDEE.



HYDRAULIC STOKERS.

For Flue Boilers, Water Tube Boilers, or any type of furnace where low class fuel is used. Suited for Fan draft under grates or steam nozzles. Will burn any class of small coal or breeze without smoke and with clear fires. Suited for forced draught. Hydraulic movements slow. Minimum wear. Minimum repairs. Can fit these Stokers complete within a few hours. Quotations and particulars on application.

COOPER & GREIG,

Engineers, DUNDEE.

SUPERHEATERS

(COOPER & GREIG'S PATENT).

THE Tubes are of solid drawn steel and are fitted in pairs into heavy steel crossheads, into which the tubes are expanded. Tubes project above level of crosshead, and are fitted with copper ring asbestos joints pulled up by heavy bolts, such joints being quite solid and proof against leakage or pressure. The Cross Main is also in steel with vertical divisions, so that steam from boiler passes through the whole set of tubes from one side to the other. We have fitted these Superheaters for many years, and experience has proved that the tubes keep perfectly clear, the scour of gas preventing any coating forming upon them. In this way the superheat remains constant from 550F to 600F depending upon breadth of flue or position of Superheater. Where required we fit Superheaters into separate downtakes with adjustable dampers. The Superheaters may be fitted for independent firing, or may be fitted to suit Water Tube Boilers as desired. The economy we have obtained by introducing the Superheater where engines and boilers have been burdened has been over 20 per cent. in coal. Any pair of tubes may be removed and replaced through top door within a few minutes if required without disturbing any other pair.

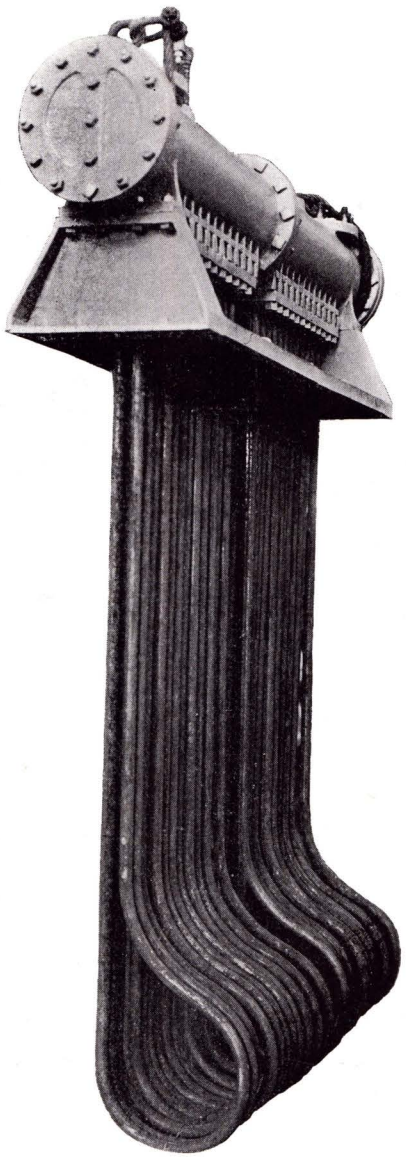
The Tubes of Superheater are shown straight on photo, but we re-set them for double flow of hot gas to suit any downtake. Angle doors are fitted upon bevel sides of carrying brackets.

SUPPLIED to many TEXTILE MILLS and GENERAL FACTORIES.

REFERENCES ON APPLICATION.

APPROVED BY BOILER INSURANCE COMPANIES.

SUITABLE FOR WATER TUBE BOILERS.



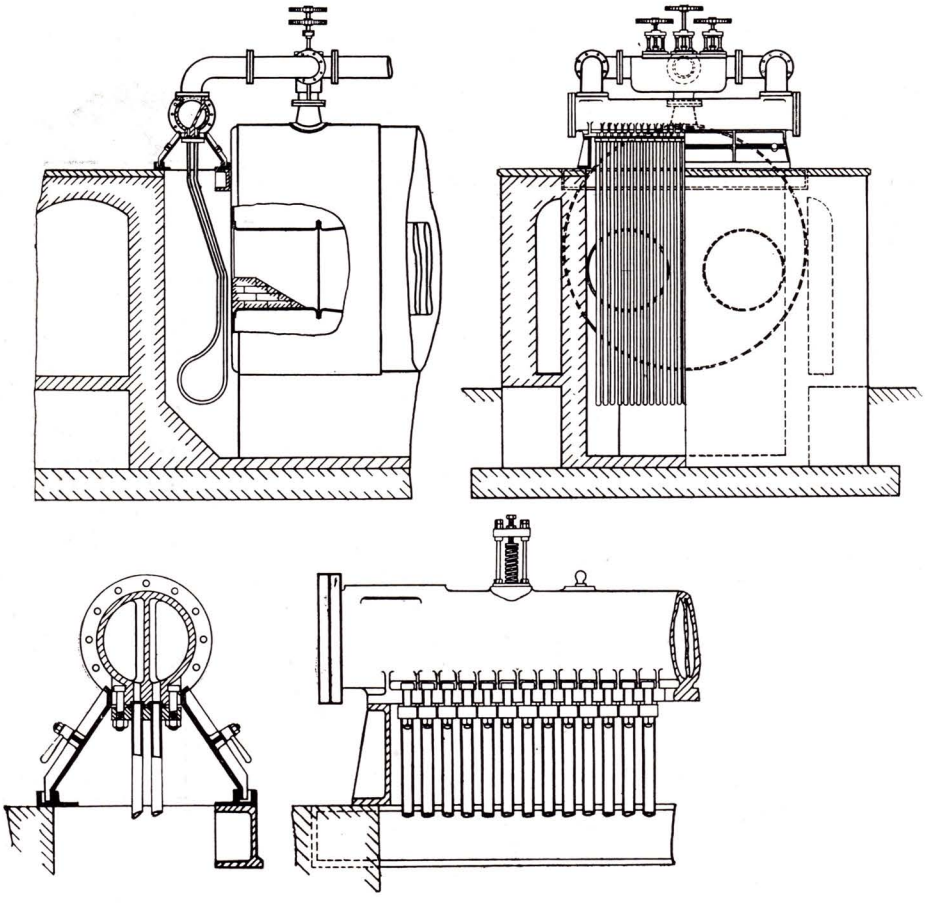
SPECIAL FEATURES.

All Tubes can be removed and replaced within a few hours.

No large flat joints; all ring joints in copper and asbestos.

No joints buried in brick work.

All Coils accessible and easily withdrawn for examination without risk of damage.



STEAM SUPERHEATER FOR ORDINARY LANCASHIRE BOILER.

The tubes are of solid drawn steel and are fitted in pairs into heavy steel crossheads, into which the tubes are expanded. Tubes project above level of crosshead, and are fitted with copper ring asbestos joints pulled up by heavy bolts, such joints being quite solid and proof against leakage or pressure. The Cross Main is also in steel with vertical divisions, so that steam from boiler passes through the whole set of tubes from one side to the other. We have fitted these Superheaters for many years, and experience has proved that the tubes keep perfectly clear, the scour of gas preventing any coating forming upon them. In this way the superheat remains constant from 550F to 600F, depending upon breadth of flue or position of Superheater. Where required we fit Superheaters into separate downtakes with adjustable dampers. The Superheaters may be fitted for independent firing, or may be fitted to suit Water Tube Boilers as desired. The economy we have obtained by introducing the Superheater where engines and boilers have been burdened has been over 20 per cent. in coal, also enabling engine to carry away the full load from the start without any slowing down. Any pair of tubes may be removed and replaced through top door within a few minutes if required without disturbing any other pair.

COOPER & GREIG,

Engineers, DUNDEE.

STEAM TURBINES.

The Steam Turbine has been successfully used for the driving of Electric Generators, and for fast vessels, also for centrifugal pumps taking water or air, in this way taking up a position which the construction and the movement is exceptionally well suited for.

The Reciprocating Engine is more suitable for comparatively slow speeds, where it may be directly coupled to shafting, or through ropes or gear to different lines from one fly wheel.

The speed of vessels at sea has been greatly increased since the advent of the Turbine. There has been some difficulty in the application in order to get the screw propeller adapted to meet the best conditions for the efficiency of Turbine, but for very fast vessels there is no difficulty whatever. The Oil Engine promises to take up an intermediate position for quick vessels and others, although for convenience in starting and low upkeep there is nothing at present to equal the Steam Turbine.

One notable application of the Steam Turbine has been in taking up the position of a Low Pressure Engine; that is to say, the Turbine is well suited for working out the efficiency of steam plant when it is arranged to act as an auxiliary to the Reciprocating Engine. Steam may be passed to the Turbine a little over or under atmospheric pressure and then expanded to the lowest available vacuum with increasing efficiency of the combination as a whole.

Where steam is condensed and used over and over again, as with surface condensing plant at sea, the resulting water from a turbine plant is entirely free of oil. This is a great convenience in that the water is practically pure for use in boilers, or for many other purposes, and no oil is required for internal lubrication, as there is no metal contact with acting parts. The Turbine Engine offers many advantages where the speed of revolutions is an element of efficiency.

Suitable for any class of Mill where Electric Motors are in use for lighting or power purposes; and as a low pressure engine, will obtain greater power from same weight of steam if condensing water is available for condensing purposes.

COOPER & GREIG,

Engineers, DUNDEE.

COOPER PATENT STEAM TURBINE.

POINTS OF INTEREST TO STEAM USERS.

No. 1.—Steam economy guaranteed under conditions of loading and use.

No. 2.—The construction, for a comparatively slow turning movement, is as shown on Photo Print on following page.

No. 3.—For driving Electric Generators, diameter, length, and revolutions are modified as shown on other Plates, the Electric Generators being carried upon extension of same Soleplate.

No. 4.—Where Slow-speed Shafting is driven direct, or rope drum used for driving Shafting, the method is shown upon Plate page 34. A speed of 300 drum revolutions may be used according to power and purpose intended. A special Gear Box being fitted between Turbine and Slow-speed Shafting with Compensating Couplings, Turbine then runs at suitable steam speed, while Shafting runs at speed for general purposes.

No. 5.—The general construction enables examination of Blading to be made without difficulty.

No. 6.—Blading is entirely in Steel rom special Bars formed by Machines, the surface of Blading is polished, and the root fastening is so arranged that the full strength of Material is made use of between Wheel rim and Blading. Each pair of Blades lock together, and when Diaphragms are in position the Blading is entirely enclosed. Rotation of Wheels tends to hold Blading more firmly in place.
It will be noticed that each pair of Blades are independent of any other pair, and that the roots are broader than the actual Blades, so that the whole breadth of Wheel rim is made use of, while the acting Blade portion is protected. Sudden heats through quick starting of Turbine does not affect the fastenings, as the Wheel rim and Blading expand together. In proof of the firmness and strength of Blading, we drive a Milling Cutter over the tips of Blades after Wheel is completely bladed, the Wheel being moved by worm turning gear, while Milling Cutter is moved across Blades by side rest, in this way trueing wheels in position. This operation supplies a very certain test for any fault over and above ordinary inspection.

No. 7.—The Blading and Spacing are completed by Machines, and the Blades pressed into position by special hand tools. Any pair can be removed or replaced while Rotor is in position.

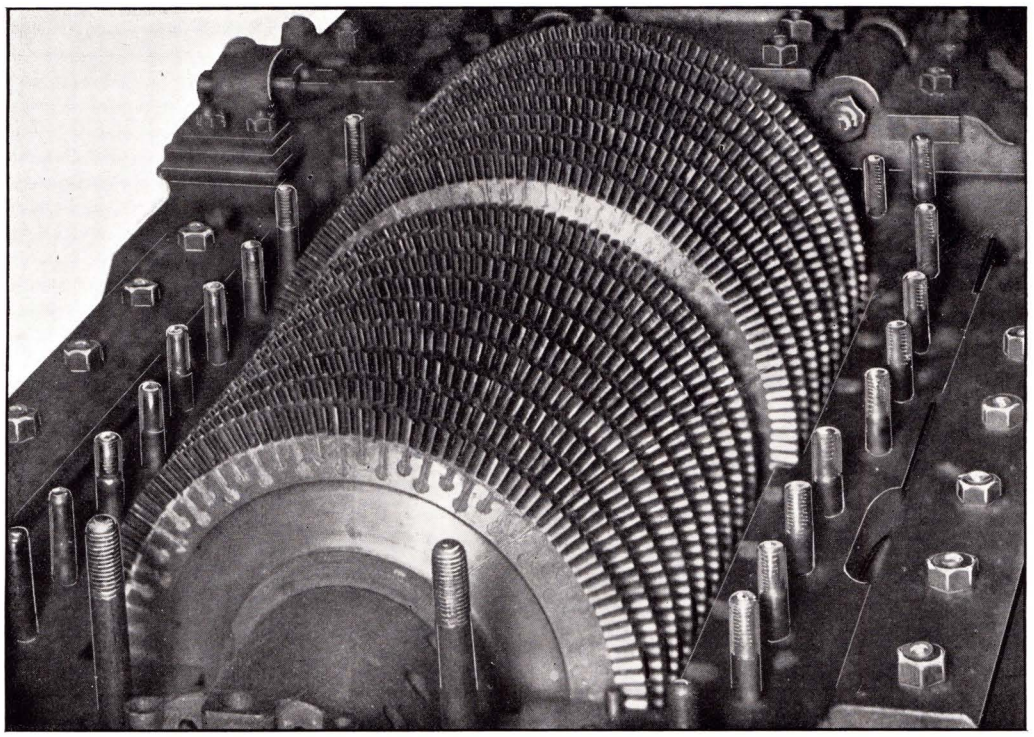
No. 8.—The Diaphragms are also formed with the Steel Guide Blading, ground and polished for the proper direction of steam. The Diaphragms are held by tongue pieces, so that their proper position is assured, and no difficulty obtains in opening up or building in after examination.

No. 9.—The Thrust Blocks and Main Bearings are supplied with Oil under pressure, the Oil being collected from Oil Well, and returned by pipes to Oil Cooler and Filter. In this way the Journals are kept under a steady pressure of clean, cool Oil. Oil Pump is of spur wheel pattern, and is driven by downward extension of Governor Spindle.

No. 10.—A powerful Centrifugal Governor is coupled by lever to double-beat Throttle Valve. A separate emergency Governor is also fitted to shut Main Stop Valve, after allowing a fixed degree of overspeed, as desired. Governor Spindle is driven by Machine-cut Worm Gearing from Turbine Shaft. An auxiliary Steam Valve is also fitted for use where increase of power is required during temporary overloads.

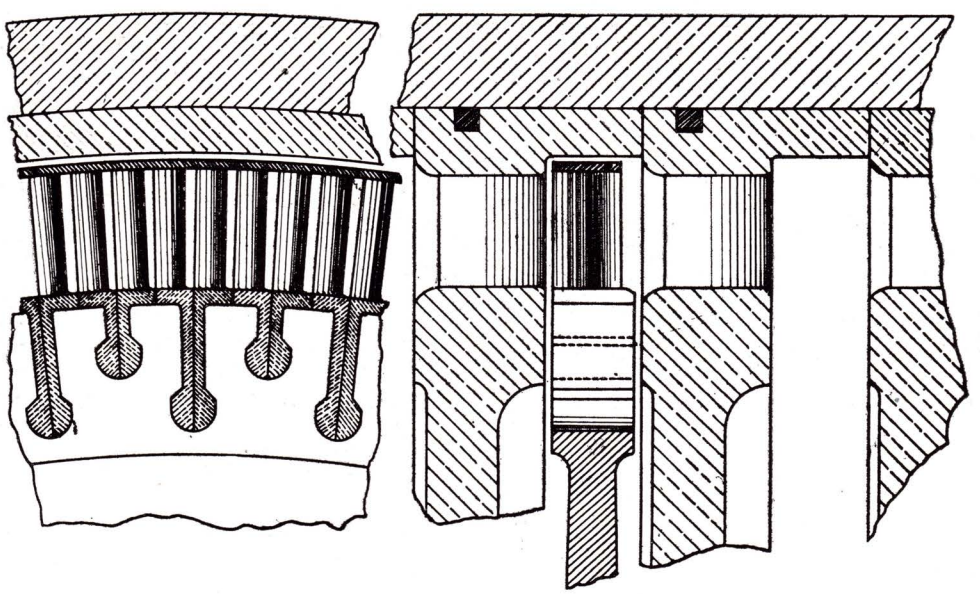
No. 11.—The whole Machine is of very strong proportion, and fitted with large Shafting and Journals, suited for high-pressure superheated steam, to work with Condenser or non-Condensing as required.

No. 12.—It may be mentioned, however, that the Turbine is most efficient when highest possible vacuum can be obtained, and should always be used as a Condensing Engine where best economy is required.



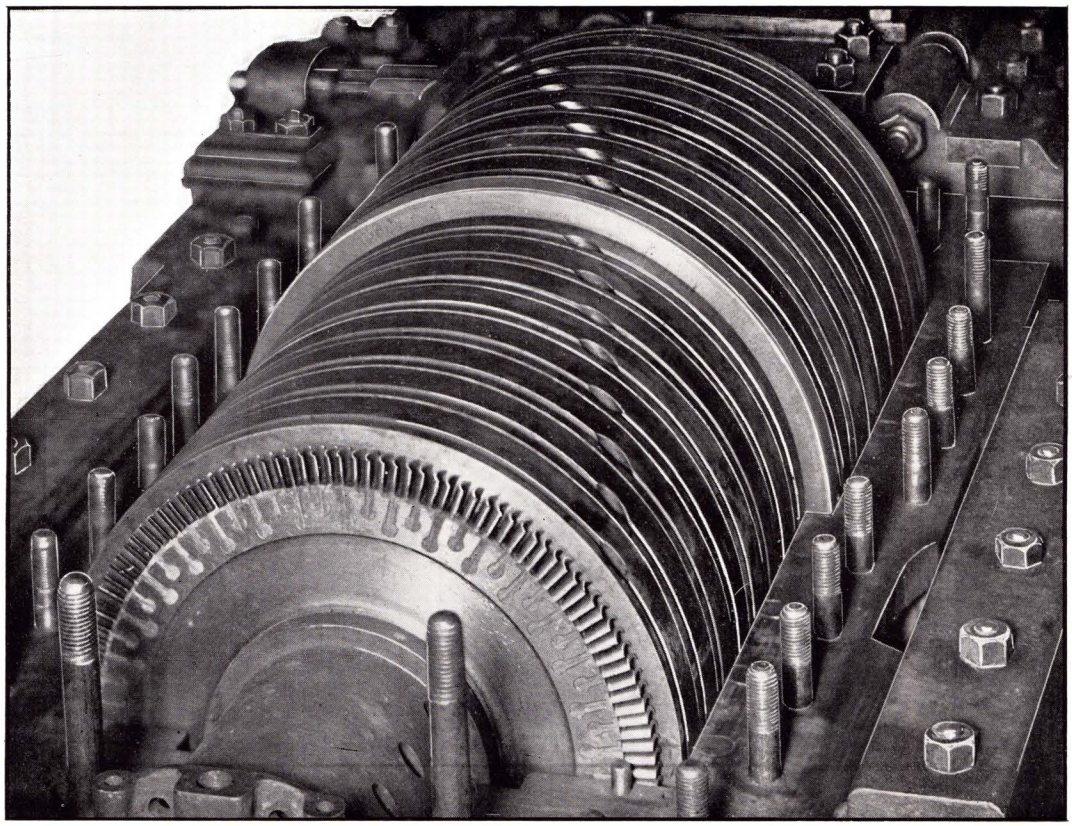
HIGH-PRESSURE ROTOR IN POSITION WITH BLADING EXPOSED.

Blading is in special steel, and fitted in such a way that the action of Turbine holds each pair of blades with a firm grip. Any pair can be removed or replaced without lifting Turbine Rotor, special hand tools being used for this purpose. Blading may also be fitted in bronze, highly polished, and suitable for any class of work, either as complete Expansion or High-Pressure Reducing Engine, or as Low Pressure Engine only.



SIDE ELEVATION AND CROSS SECTION OF ROTOR BLADING AND DIAPHRAGMS.

The Blading is fitted in pairs alternately with diagonal pitching, so that the greatest strength of material is retained in section of Rotor and Blading. Rotor and Blading can be completely examined at any time without lifting Rotors from journals. The Blading is completely formed by machines from steel bars, and fitted into position by special hand tools ; the same hand tools when reversed will remove Blading. The Rotors are prepared for Blading by special machinery, so that the whole operation can be most accurately finished and balanced. Blading may be of bronze where desired for special purposes, but the steel is recommended and preferred for high super heats.

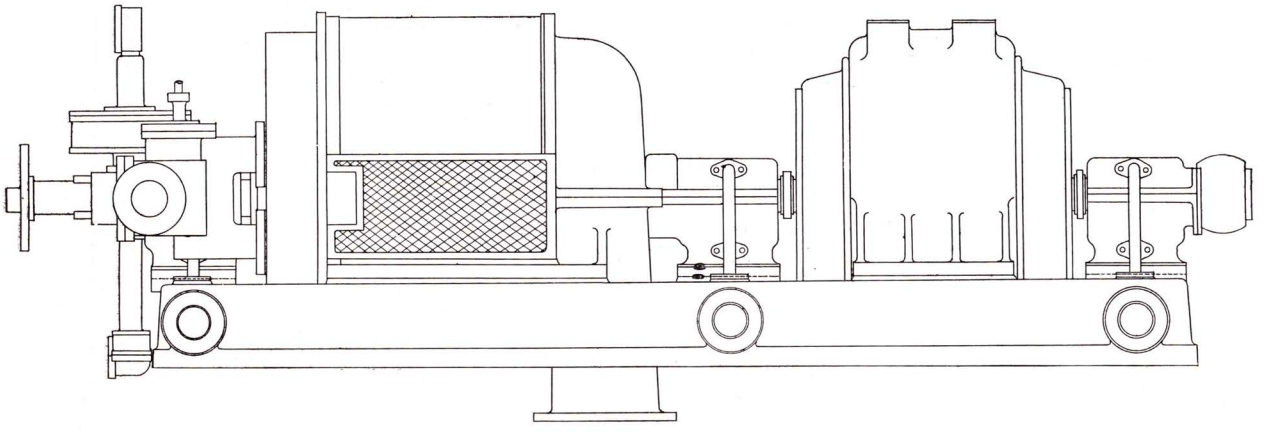


HIGH-PRESSURE CYLINDER WITH DIAPHRAGMS IN POSITION.

The Diaphragms carry the fixed Guide Blades which are also in steel, each Diaphragm being fitted in such a way that any one can be removed as desired after lifting cover. A cord joint is all that is required for cover jointing inside of bolts.

COOPER & GREIG,

Engineers, DUNDEE.

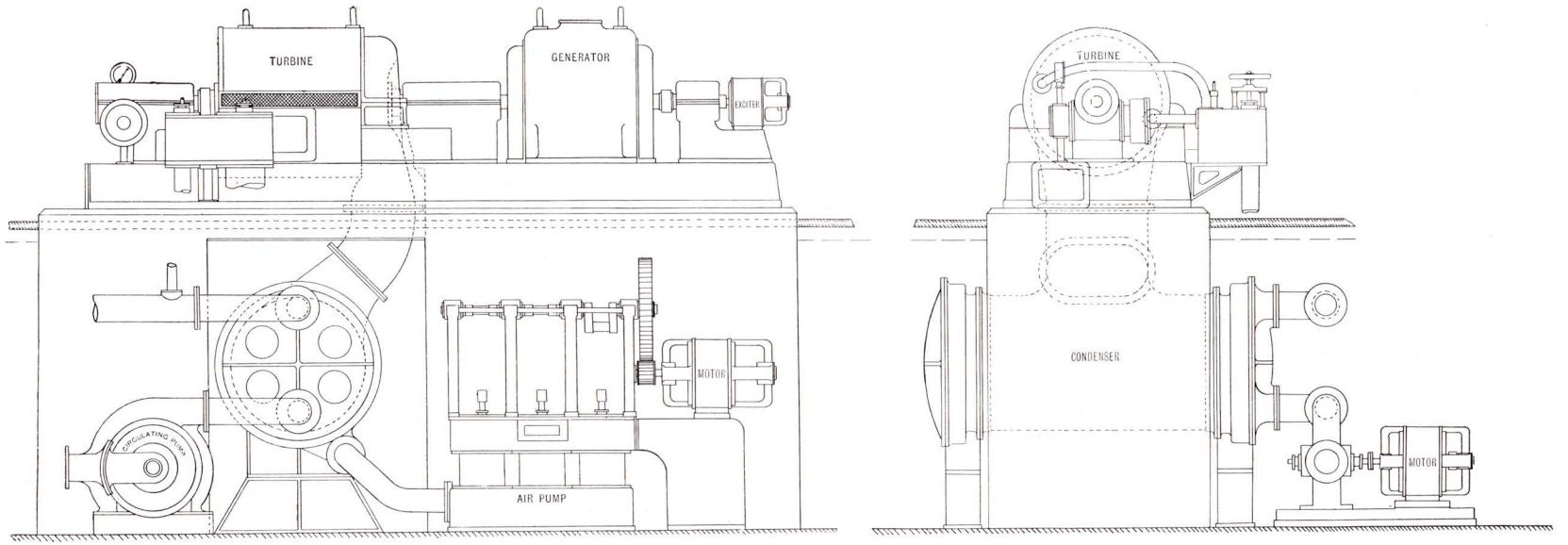


COOPER PATENT COMPLETE EXPANSION TURBINE.

For Electric Generators driving Air Blowers, Water Turbines, &c.

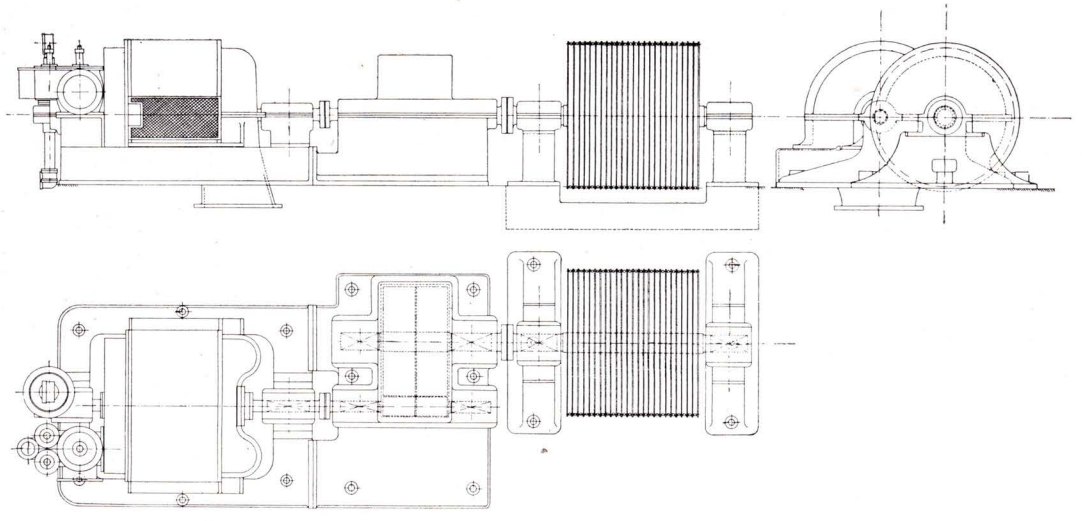
This construction is suitable for the highest pressures of superheated steam and for an expansion carried to the lowest vacuum obtainable. The Electric Generator is placed upon extension of soleplate.

For quotation purposes please say power required and available pressure of steam, also voltage, and whether continuous or alternating current, with particulars of voltage, periodicity, &c.



MIXED PRESSURE TURBINE WITH CONDENSING PLANT AND ELECTRIC GENERATOR.

The Mixed Pressure Turbine has many special advantages. The whole available steam from non-condensing engines may be fully used and reduced to the lowest attainable scale of vacuum level, and although of varying quantity this is immediately compensated by governor. The governor controls the inlet of compensating live steam and the bye-passing of low-pressure steam, so that under any condition of loading, or any variation of quantity or weight of exhaust steam, the speed and power can be fully relied upon, the speed within very close limits.

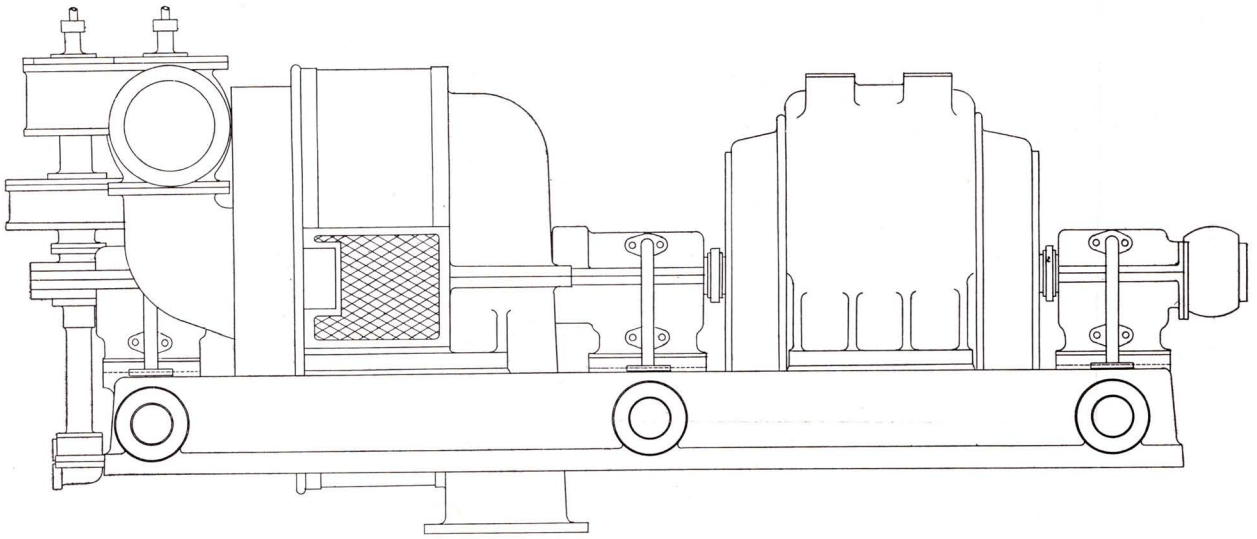


Shows Application of REDUCTION GEAR TO TURBINE WITH ROPE DRUM
Fitted for Driving by Ropes to Shafting.

The Cooper Patent Turbine may be applied for driving shafting direct, or through Reduction Gearing in separate gear case; these gears are cut in high tensile steel with double helical teeth of special design. The Turbine and Gear being coupled with flexible couplings, so that no strain operating upon one set should affect the other; where rope drive is required a suitable and efficient speed is obtained for ropes upon rope drum, the drive being made suitable for diameter of rope proposed to be used. The Turbine requires no fly wheel, so that a very compact and most economical arrangement can be obtained with many incidental advantages.

COOPER & GREIG,

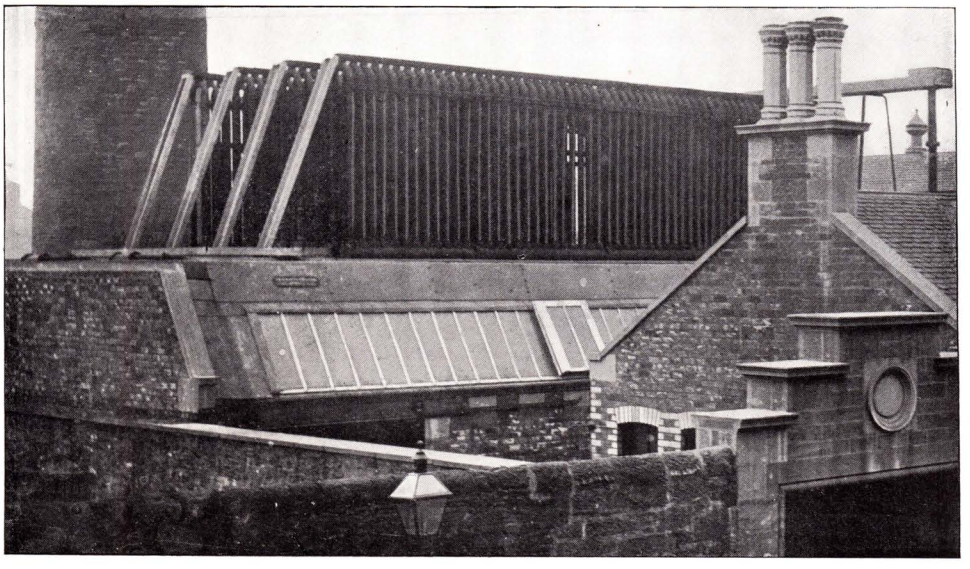
Engineers, DUNDEE.



COOPER PATENT MIXED PRESSURE TURBINE

CONSTRUCTED FOR USE WITH EXHAUST STEAM DISCHARGED FROM RECIPROCATING ENGINE.

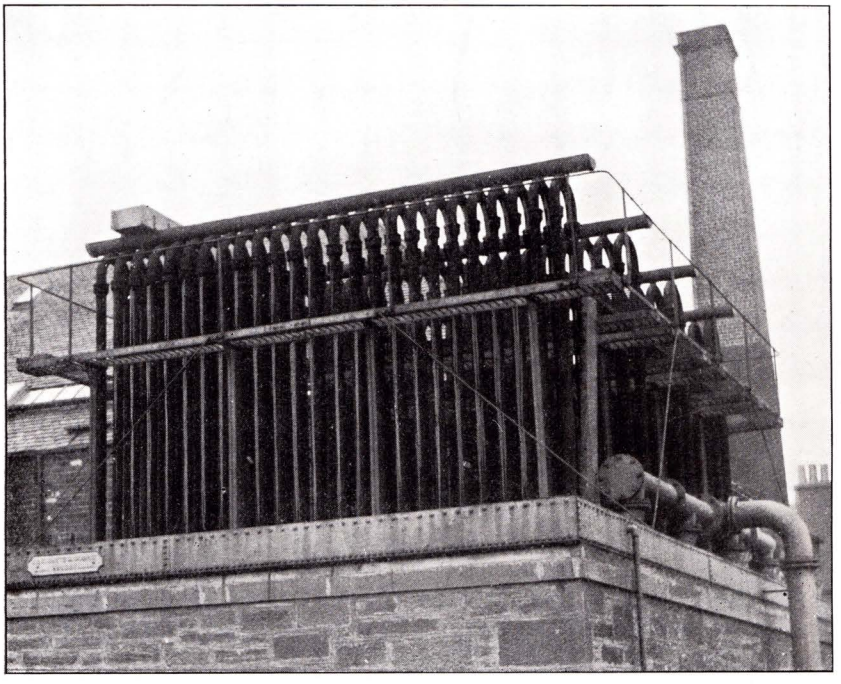
Where the exhaust steam diminishes through varying loads or irregular action of Piston Engines, the Turbine is so constructed that live steam is taken into use to make up the supply required, the governor having connection with regulating valves both upon exhaust and live steam branches. Electric Generator and Exciter are placed directly in line of Turbine centre and upon same soleplate, making a compact and firm combination. The Oil supply being an essential feature of all quick running shafting, the oil is circulated under ressure and is filtered and cooled before re-entering journals.



STANDARD TYPE OF EVAPORATIVE CONDENSER

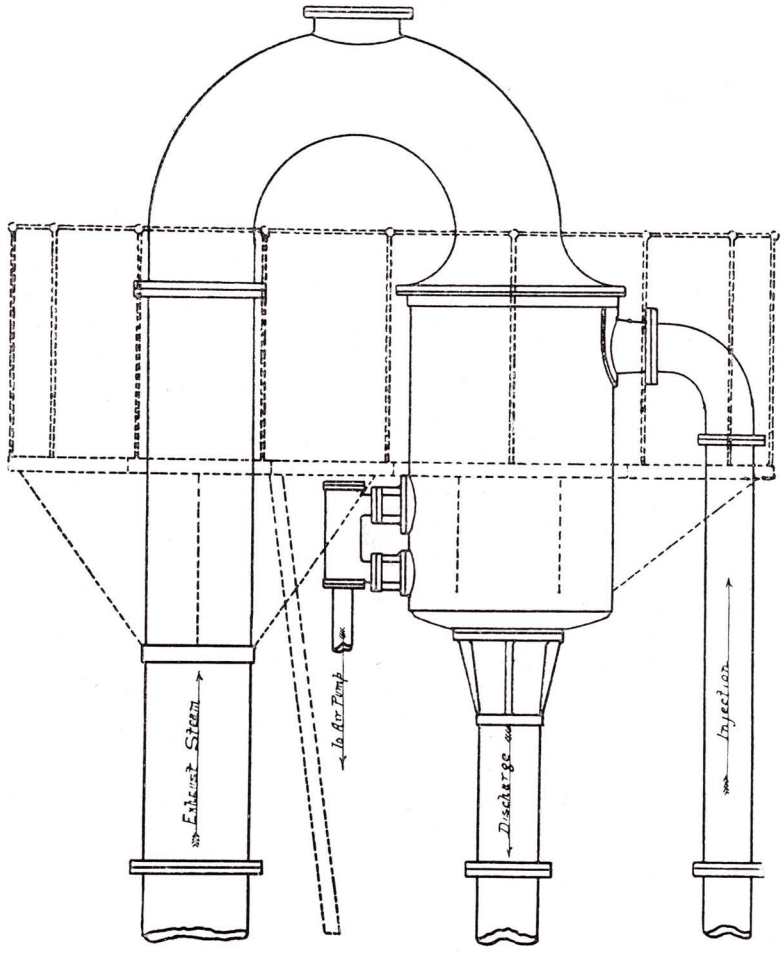
IN SEPARATE NARROW TANKS.

For Electric Lighting Stations, Mills, and Coal Pit work, the separate tanks allow for expansion when Condensers cover a large roof area, each tank being bridged over between top edges by reverse curved plates or frames with roof-lights, so that the engine room or workshop underneath may have light and ventilation as required. The tanks are made with curved under edges four to five feet in breadth, forming a very neat and strong roof, especially where roof-lights are placed between each section. The advantage of an Evaporative Condenser is not fully recognised by power users. The water required for operation has not to be cooled after use, condensation being effected by evaporation of water directly from outside of tubes, not as with ordinary jet or surface Condensers, the cooling of water being a separate process which must be completed before water can be used again. By using our Evaporative Condenser where a non-condensing engine has been in use the saving in coal and water alone repays the cost of installation within a very short time. Where cooling ponds take up valuable space, we have fitted those Condensers, as shown in plates, upon roof of buildings. A vacuum of 25-27 inches being obtained with reasonable sizes, a 28 inch vacuum requires larger sizes. We have had Condensers in use for over twenty years, and having broken pipes for examination have found them as good as when originally supplied. These Condensers cost practically nothing for upkeep, year in and year out.



EVAPORATIVE CONDENSER IN A LARGE SINGLE TANK, FORMING COMPLETE ROOF TO ENGINE ROOM.

These Evaporative Condensers we have constructed for many years. They require no particular attention other than to keep the troughing along top of bends free of any articles which might be deposited by the wind. The water evaporating from outside of Condenser amounts to about three-fourths the weight of feed water condensed from steam, so that where Engines are being used non-condensing, an immediate and great economy may be obtained by fitting in position an Evaporative Condenser and Air Pump. With any other form of Jet or Surface Condenser the water after being once used must be cooled before further use, but with the Evaporative Condenser no re-cooling is required. The actual work of condensation is completed by the evaporation of water from outside of pipe surface while the condensation of steam goes on inside, the latent heat being carried off to the atmosphere without further manipulation. Where space is cramped we supply Evaporative Condenser with Fan Draught. This of course adds to the working costs in power spent in driving fans, although the saving in capital costs and fuel would in many cases discount the cost of power required.

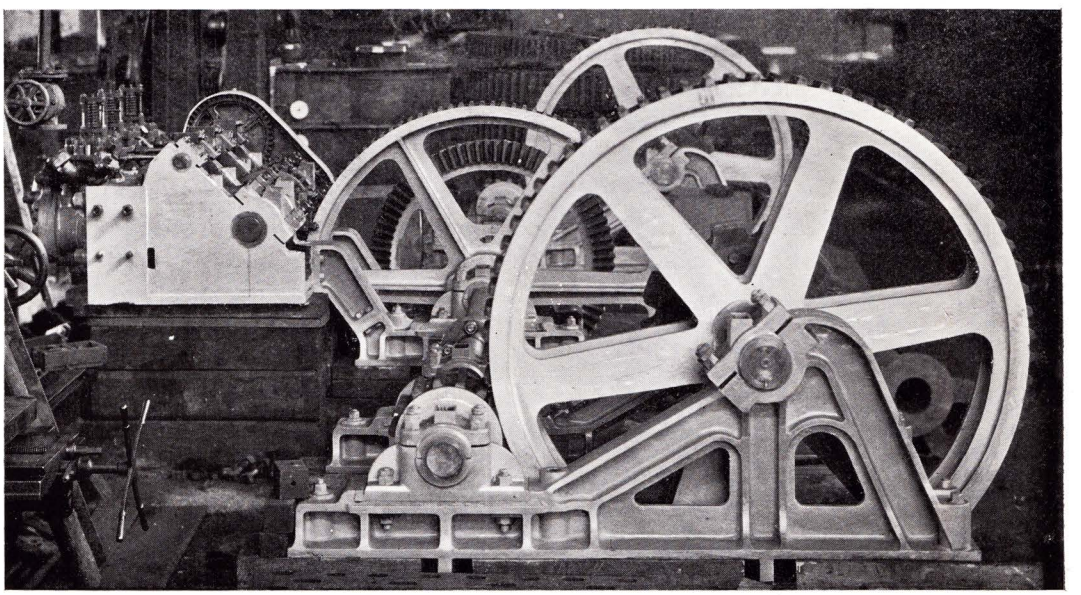


BAROMETRIC CONDENSER HEAD WITH CONTRA OR PARALLEL FLOW CONDENSING CURRENTS.

This form of Condenser dispenses with Air Pump for ordinary use, and only requires a Circulating Pump or supply of condensing water to reach the water inlet with sufficient pressure to enter and meet discharge of exhaust steam. After the Condenser is at work the power required to lift water for condensing purposes is diminished in respect of vacuum being obtained in Condenser Head. Where injection water is heavily charged with air, or where a specially near approach to the limit of barometric pressure is required, a dry air pump connection should be used along with the discharging action of discharge water into sump tank. With Barometric Condenser in use there is no danger from water of condensation reversing and getting back into Turbine or Reciprocating Engine, as has happened with ordinary forms of Jet Condensers. With Evaporative Condenser, ordinary Surface Condenser, or Barometric Condenser, the returning of water to engines becomes practically impossible, as the water must go out at the free open end, either at sump tank or through air pump. We also supply Jet Spray Open Coolers for Cooling Tanks, or Framed Coolers, Open Stacks, or Towers, where space has to be considered.

COOPER & GREIG,

Engineers, DUNDEE.



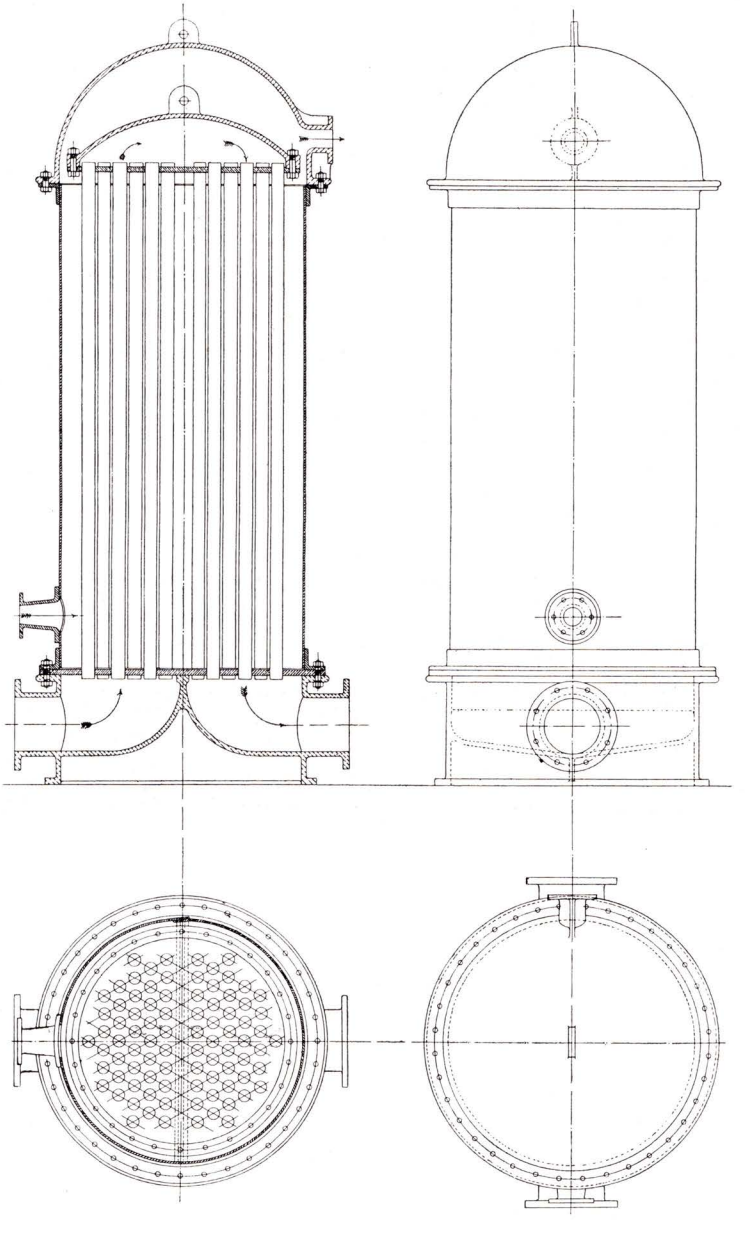
TRIPLE HYDRAULIC ENGINE AND GEARING.

One of Several Sets made for H.M.S. Dockyards for Pontoon Dock Gates.

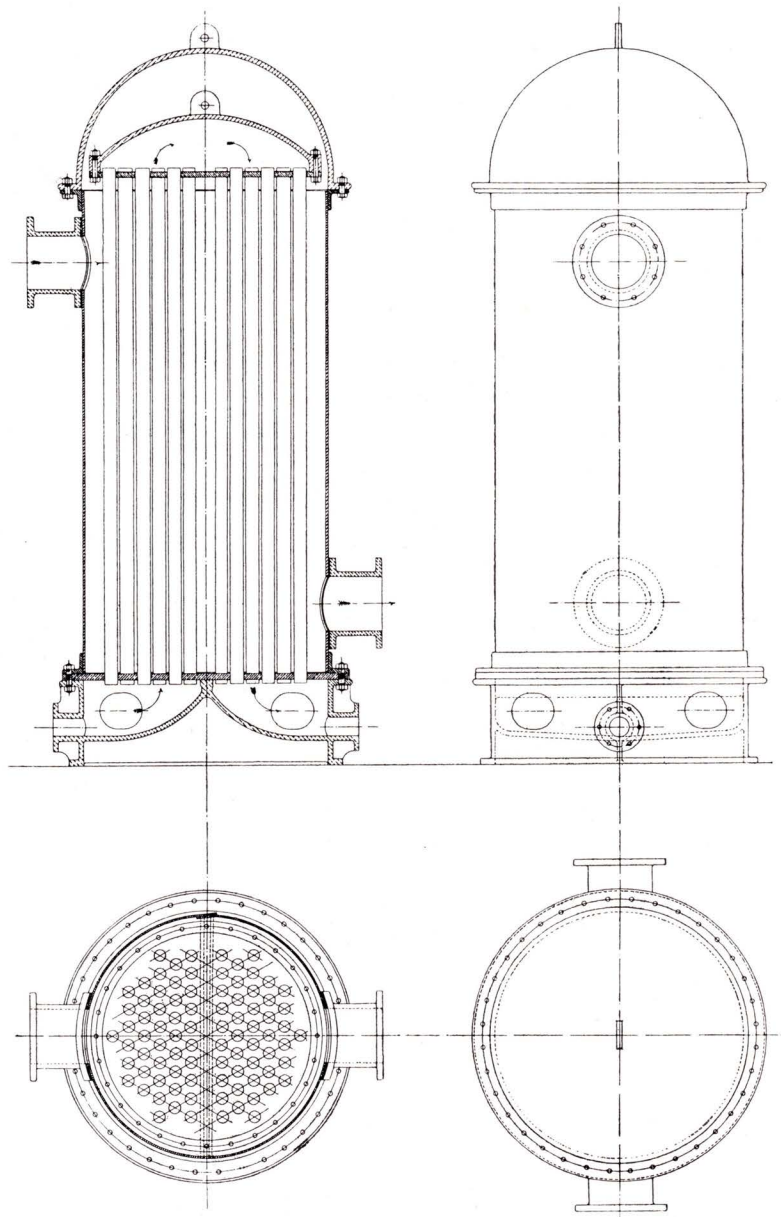
Hydraulic Gearing as a means of rotary or direct lift is most useful where occasional power is required. The Triple Hydraulic Engines for Dock Gearing works with a water pressure from 600 lb. to 1000 lb. per square inch. Valves and casing are of gun metal, valves being balanced so that no friction strain comes upon faces. The reversing valves are also balanced, so that operator has full control and automatic stopping gear has no friction load to overcome. The pitch link chains are machine divided for this gearing, and tested with a working load of 36 tons each. We also make Hydraulic and Electric Power Lifts both for passengers and goods, Electric Hauling Gear, and Steam Hauling Gear for rope gear overhead, &c.

ONE SET OF SEVERAL BRIDGES MADE FOR CROSSING DOCK ENTRANCES.

These Bridges are made in high tensile steel, and designed so that the weights are balanced upon the Cantilever principle. The Bridge being in two portions, each supported upon conned rollers moving upon a turned path of iron, which along with the centre pedestal is bolted to foundation, the centre pedestal is so formed that Bridge is held in exact position upon race, and also prevented from any vertical movement. Guide rails are placed about entrance to Bridge, so that a steady movement is obtained in opening and closing. When Bridge is brought into line for traffic two interlocking wedge blocks are fitted at junction of each half Bridge, these preventing side movement and vibration from crowding upon centre. The deck planking is in oak bolted so that renewal is readily accomplished.



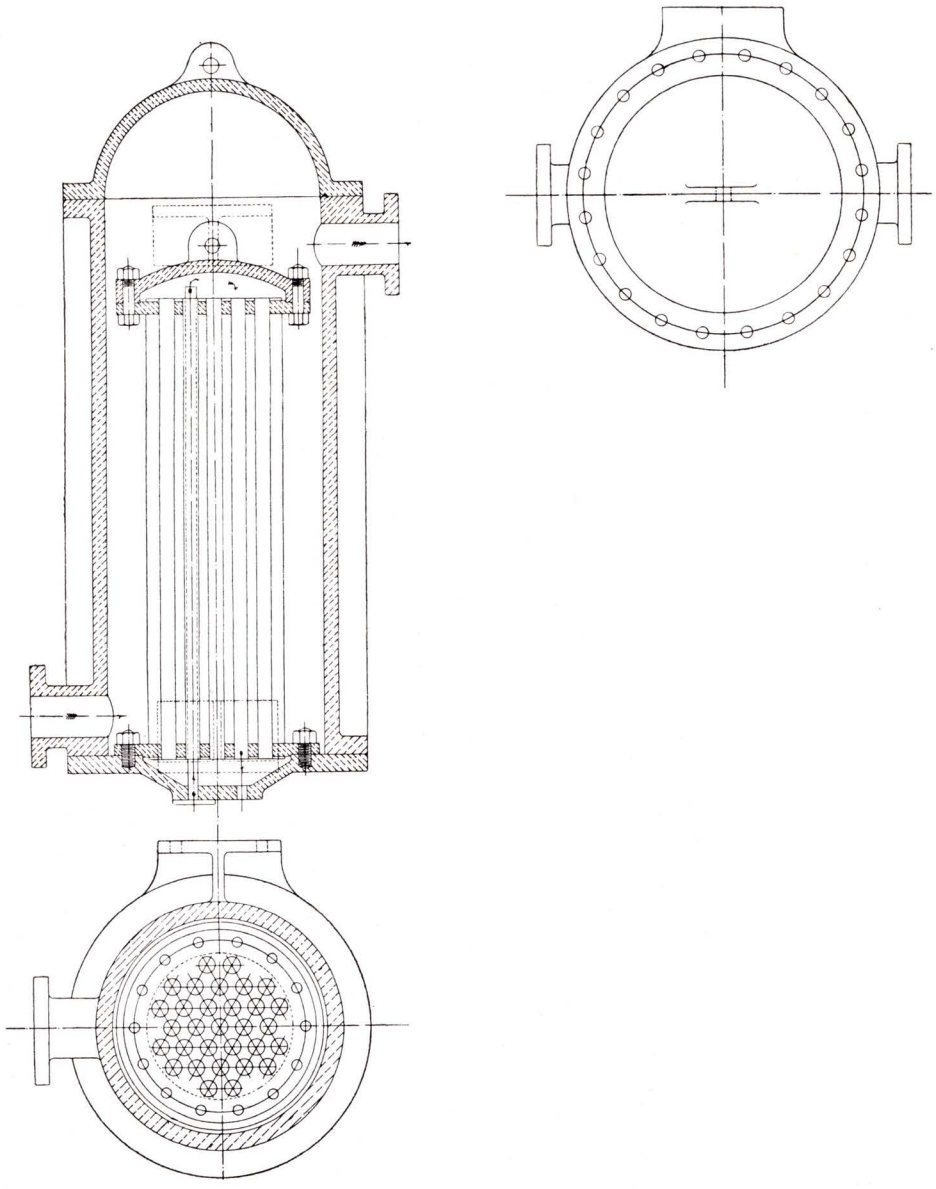
EXHAUST STEAM FEED WATER HEATER, with Feed Water inlet at bottom and outlet at top. Suitable for Condensing or Non-Condensing Engines. The exhaust steam passing through Heater will raise temperature of water from 50° and 60° up to 140° and 200° F., according to size and whether Condensing or Non-Condensing Engine is coupled.



EXHAUST STEAM WATER HEATER, with Exhaust Steam inlet at top and outlet at bottom.

COOPER & GREIG,

Engineers, DUNDEE.

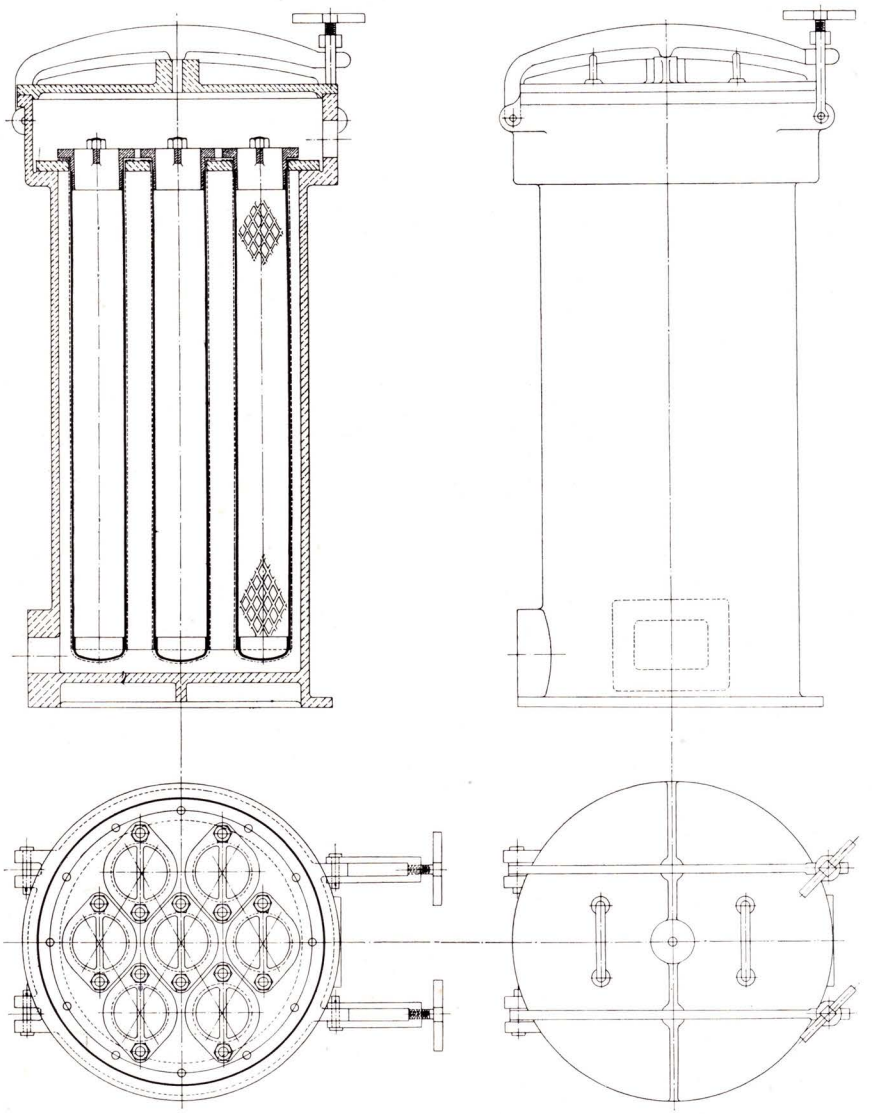


LIVE STEAM FEED WATER HEATER for High Pressure and Temperature.

The Live Steam Heater is made of any size and capacity, either in cast iron or steel plates. Tubes are in brass, tube plates in steel or brass. Saves damage against cold feed water and raises efficiency of boilers. For quotations please say quantity of feed water and pressure of steam.

COOPER & GREIG,

Engineers, DUNDEE.

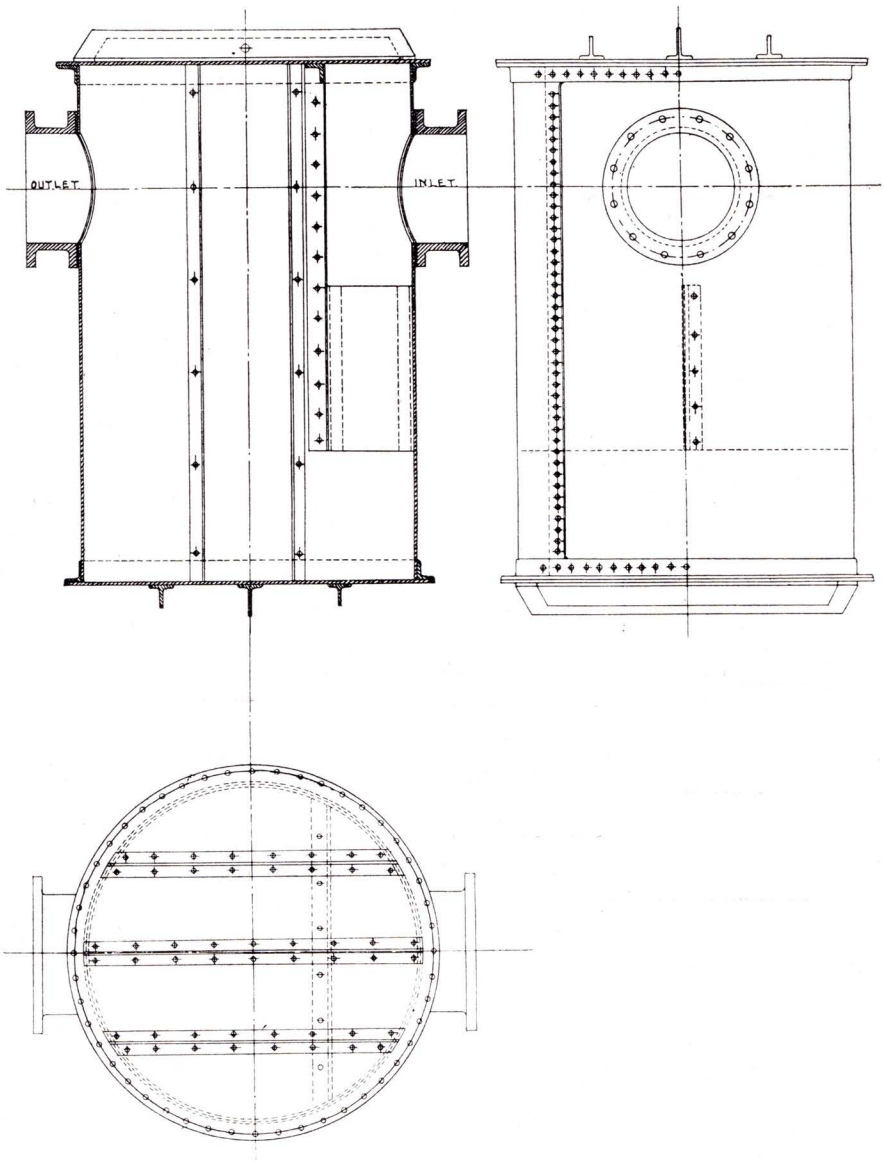


FILTER.

With lifting-out Cases and Hinged Cover; convenient for examination and cleaning. Water enters by bottom connection and leaves from top after passing through filtering medium. We make these Filters for suction or pressure service, and also with flat screens where such type suits the better convenience of machinery arrangements.

For quotation purposes please say quantity of water handled per hour and probable quantity of oil used for engines per hour.

When complete separation of the emulsified oil is required, the Chemical Filter is available. We will also be glad to quote for these; but for ordinary purposes, where boilers are regularly examined and cleaned, the Mechanical Filter answers perfectly.

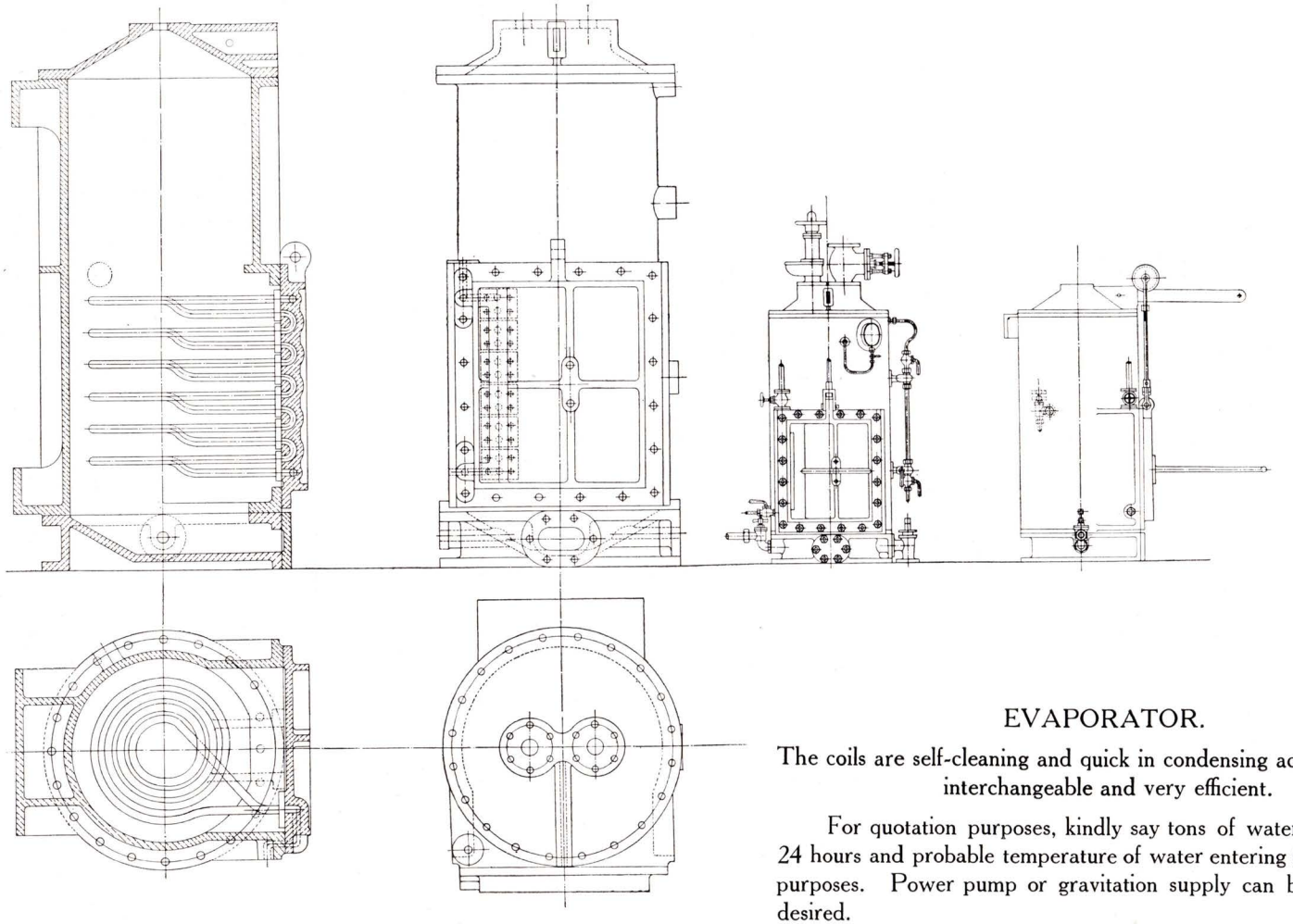


OIL SEPARATOR.

With Separators complete that gather oil and water from the steam passing through without obstructing, Water Gauges, Drain Valve, and Water and Oil Traps supplied either for service over atmospheric pressure or working at low vacuum, when a Separating Pump is supplied instead of usual automatic trap.

COOPER & GREIG,

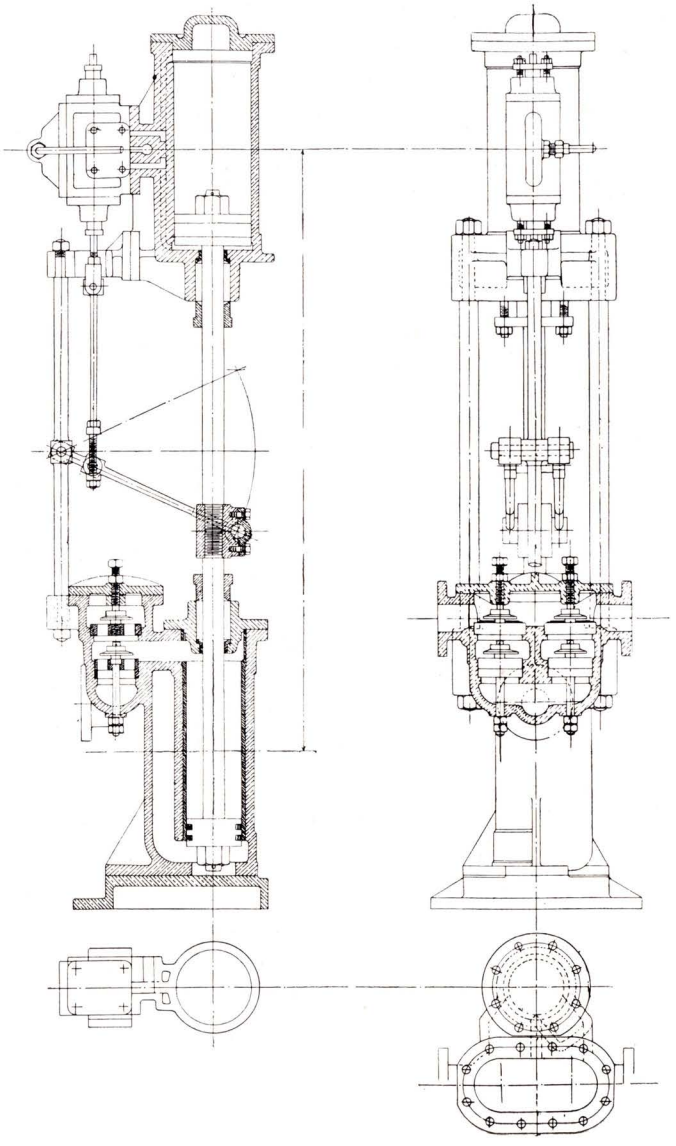
Engineers, DUNDEE

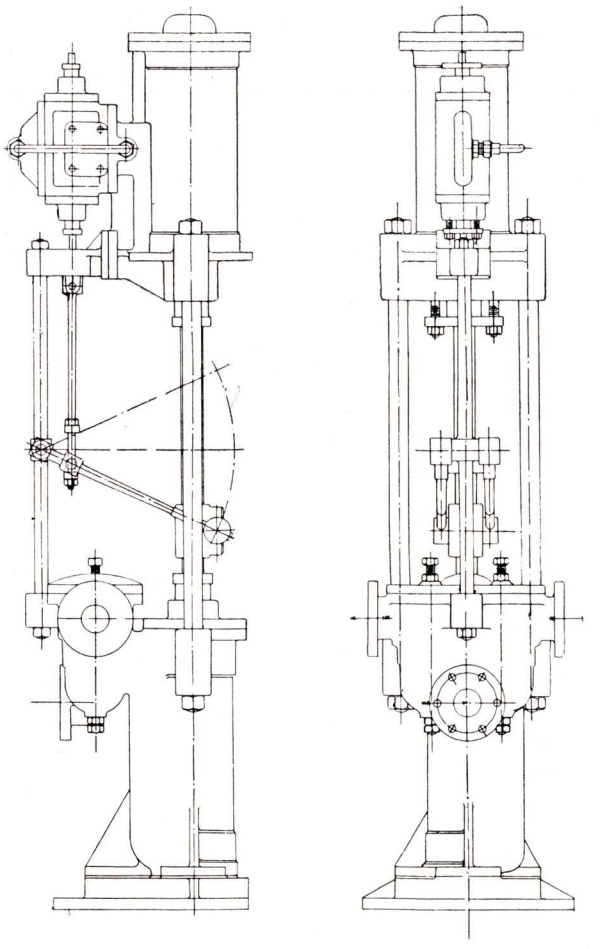


EVAPORATOR.

The coils are self-cleaning and quick in condensing action. All are interchangeable and very efficient.

For quotation purposes, kindly say tons of water required per 24 hours and probable temperature of water entering for evaporative purposes. Power pump or gravitation supply can be arranged as desired.

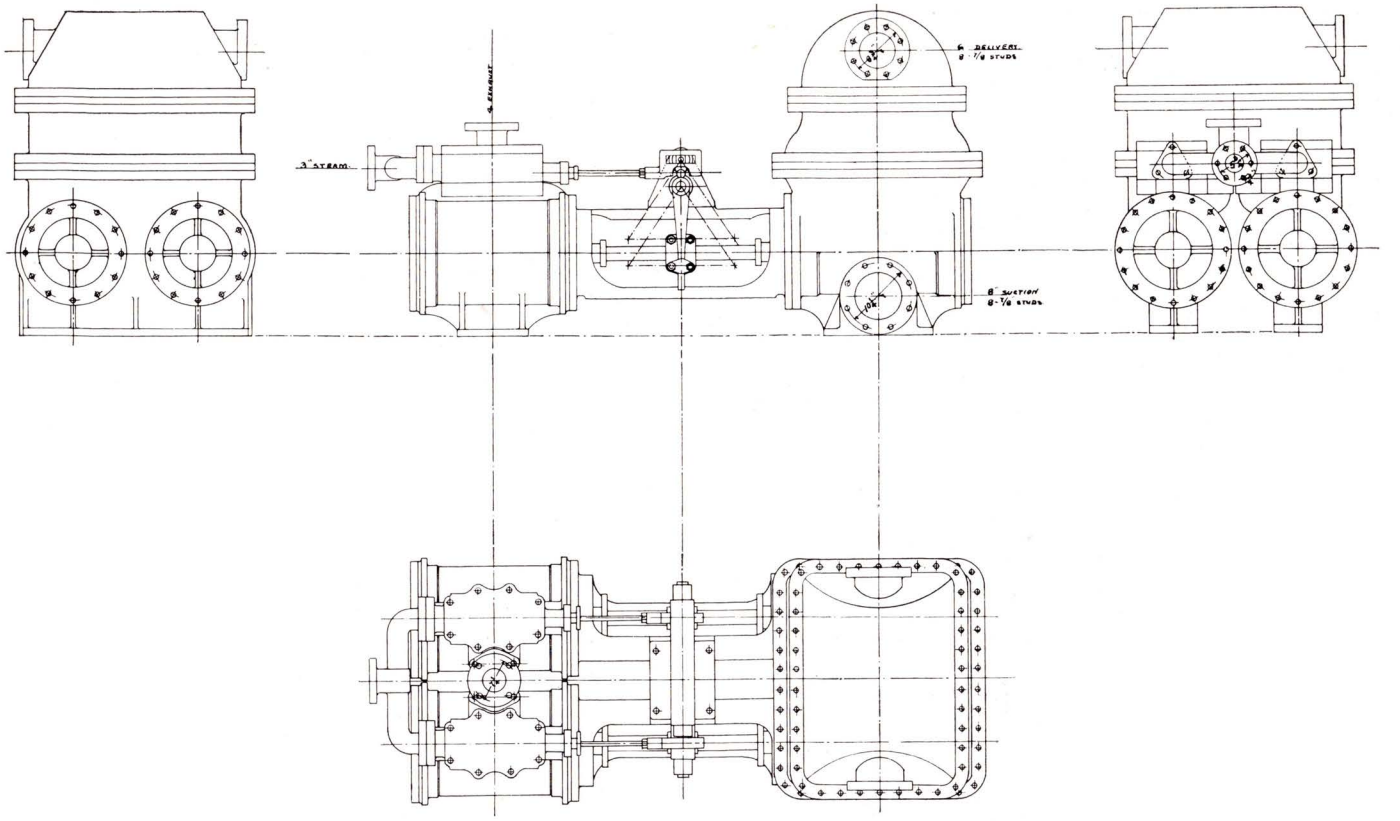




LONG STROKE FEED PUMP.

Made for any service or pressure, and fitted with automatic action.
For land or marine service.

For quotation purposes, please say available pressure of steam and quantity of water to be supplied per hour.



BALLAST PUMP.

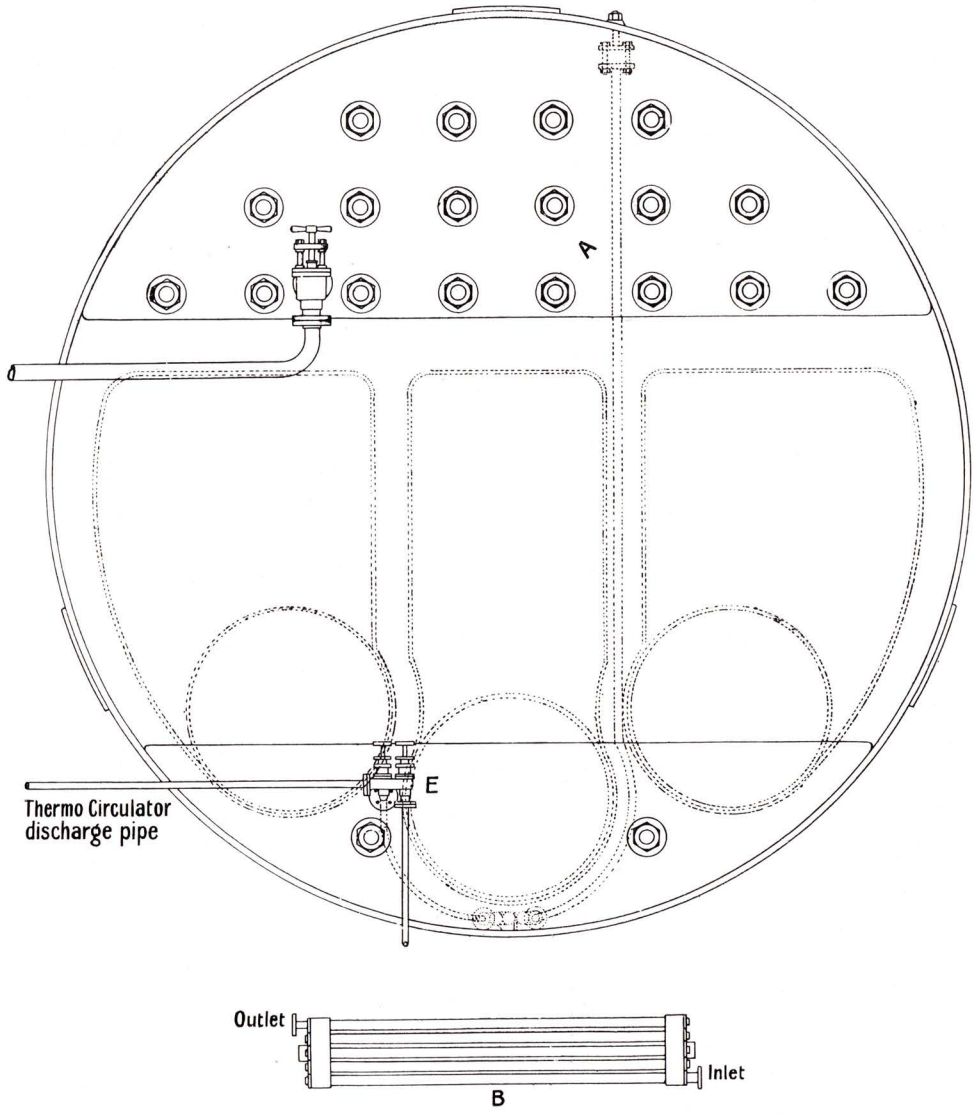
For water or oil service. Very strong and substantial for any pressure of steam and forcing. Pumps single, compound, or triple as required. Steam valves are balanced and valve motion is adjustable from outside. Brass valves in groups with brass valve seats. Brass pump rods and liners.

For quotation purposes, please say gallons per hour, steam pressure, and pumping pressure required.

COOPER & GREIG,

Engineers, DUNDEE.

FIG. I.



For quotation purposes, say size of boiler, number of furnaces, and pressure of steam.

"THERMO CIRCULATOR."

In using High Pressure Steam Boilers, it is admitted to be of the utmost importance that strains set up in the structure by unequal heating, &c., should be guarded against in order to prevent troublesome and expensive repairs.

For prevention of such expansion strains our **"Thermo Circulator"** has been expressly designed so that from the time of getting steam until the boilers are again out of commission there will be an equable temperature adjusted between all parts of the boiler.

The action of the "THERMO CIRCULATOR" will be understood by reference to Fig. I. A strongly built coil or gird (B), shorter than the length of the boiler and of a suitable width for passing through the bottom manhole, is placed as shown. One end of the coil is connected to the vertical pipe (A), the open end of which terminates in the highest point of the steam space.

The other end of the coil communicates with a valve box (E) fixed on the outside of the boiler shell or end plate. When the boiler is at work, or steam is being raised, steam passes down pipe (A) to the heating coil (B), and is there condensed, giving up its sensible and latent heat to the relatively cooler water surrounding the coil, then passing as condensed water through the valve box (E), finally being discharged to a tank or the engine hot well by a suitable steam trap; the action continuing while any sensible difference of temperature exists between the bottom of the boiler and the steam space. No air locking can take place.

In the case of a number of boilers, each heats itself, and the water of condensation is returned by a common feed pipe. Heating by the circulator is gradually and only completed when bottom plate is equal in temperature to top plate. The water of condensation being returned to boiler, there is practically no loss of heat nor is there any extra machinery at work.

A diagram is appended, which has been plotted from results of careful tests carried out on Marine Boilers fitted with the "THERMO CIRCULATOR." The curves show graphically the rise in temperature of the top and bottom plates of the boilers and the time taken to raise steam with the "THERMO CIRCULATOR" in action and out of action. The horizontal ordinate of the diagram represents the time in hours, while the vertical ordinate represents the temperature in degrees Fahrenheit. It will be noticed that with the "THERMO CIRCULATOR" out of action even after 20 hours had been allowed to raise steam to 200 lb., the temperature of the bottom plate only rose to 90° F., and, although the firing had been slow and regular, leakage occurred at shell butt straps and at bottom and front of furnaces. With the "THERMO CIRCULATOR" in action steam was raised to 200 lb. pressure in eight-and-a-half hours, the temperature of the bottom plate rising to 300° F. During this test no leakage took place at any part of the Boiler.

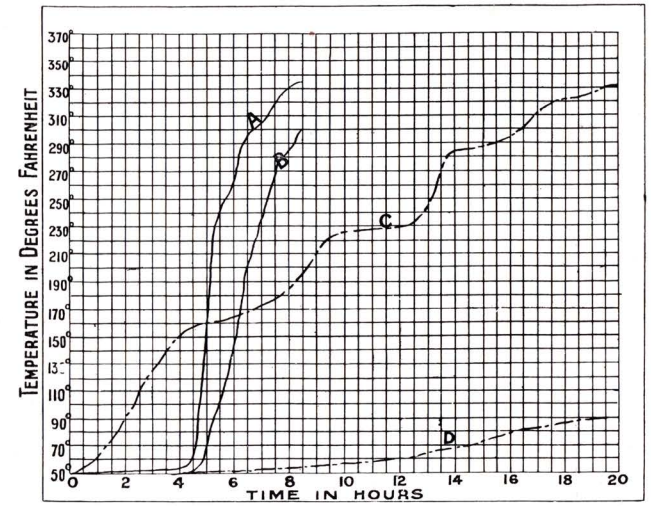
In vessels having High Pressure Boilers fitted with our "THERMO CIRCULATORS," voyage after voyage has been accomplished without any trouble from usual expansion leaks.

The "THERMO CIRCULATOR" saves Combustion Chamber Bottoms, Shell Bottoms, Ends, and Furnaces, and therefore lengthens the life of high pressure internally fired boilers.

The "THERMO CIRCULATOR" has stood the test of many years, working in both Marine and Land Boilers.

TESTS OF MARINE BOILER WITH AND WITHOUT "THERMO CIRCULATOR."

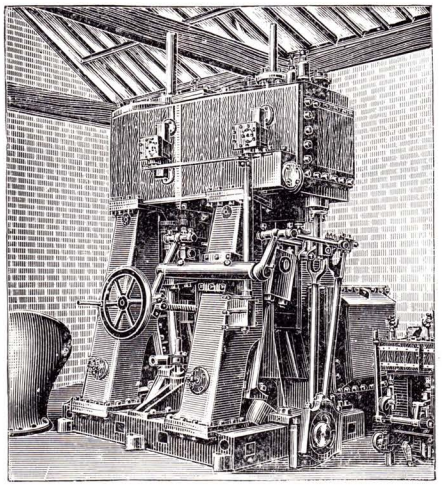
FIG. 2.



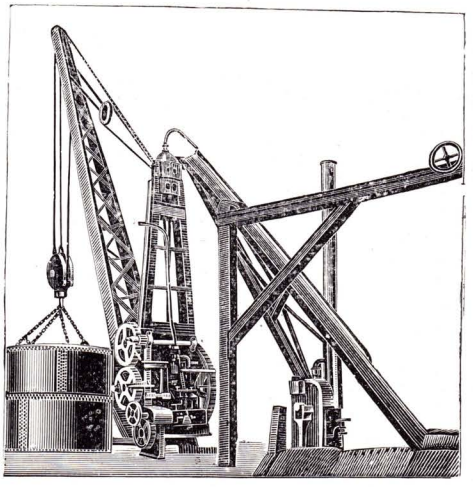
Curve A shews rise in Temperature of Boiler Top with Circulator in Action.
Curve B ,, ,, ,, Bottom ,, ,,
Curve C ,, ,, ,, Top, Circulator out of Action.
Curve D ,, ,, ,, Bottom, ,, ,,

COOPER & GREIG,

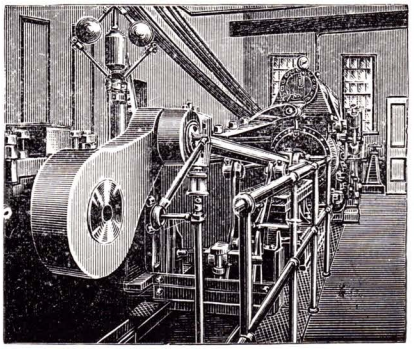
Engineers, DUNDEE.



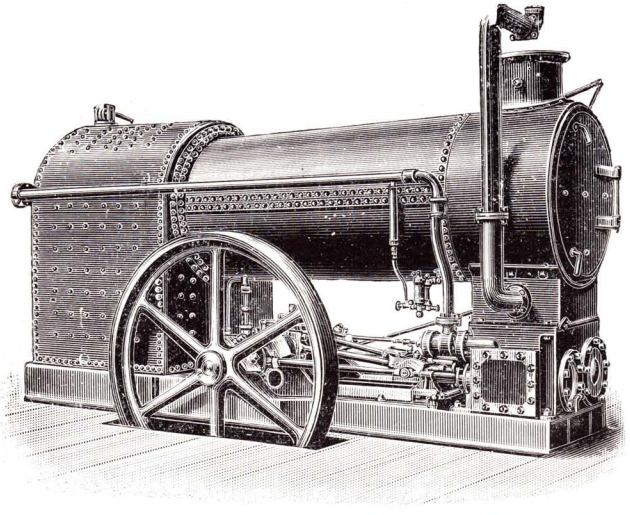
COMPOUND MARINE ENGINE
for Whaling Vessels. Extra heavy, for breaking up ice.



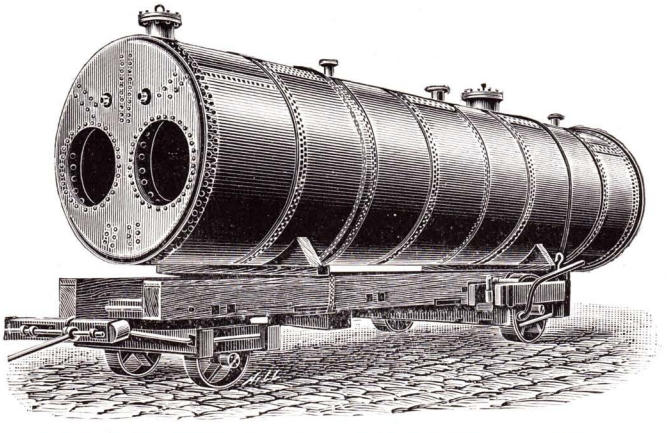
50 TON LIFT STEAM DERRICK CRANE
entirely in Steel.



5 FEET STROKE HORIZONTAL CORLESS TANDEM COMPOUND MILL ENGINE.



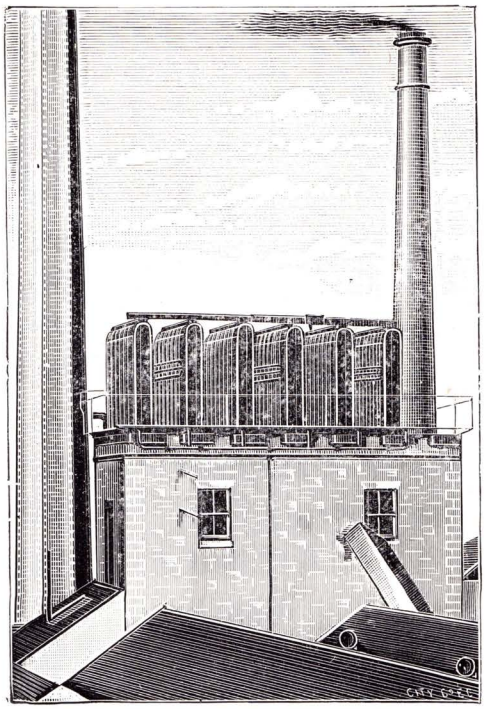
HIGH-PRESSURE COMPOUND SEMI-PORTABLE ENGINE for Saw Mills, Lighting, &c.



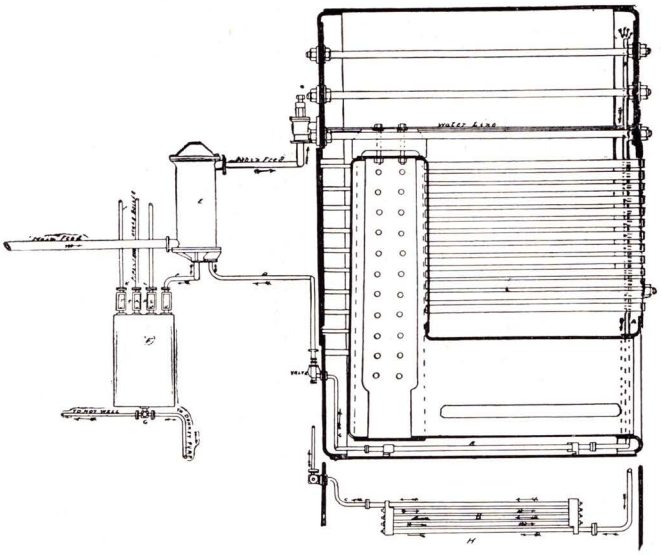
HIGH-PRESSURE LANCASHIRE BOILER
on Truck, ready for dispatch.

COOPER & GREIG,

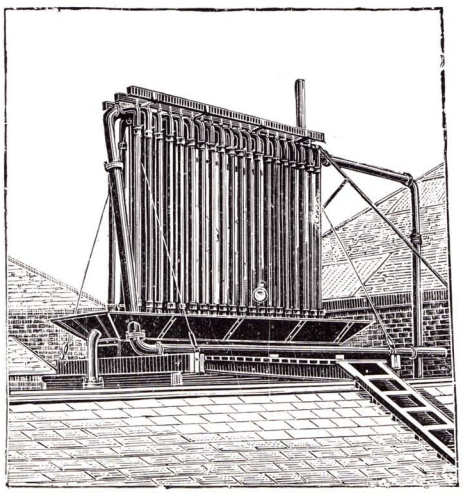
Engineers, DUNDEE.



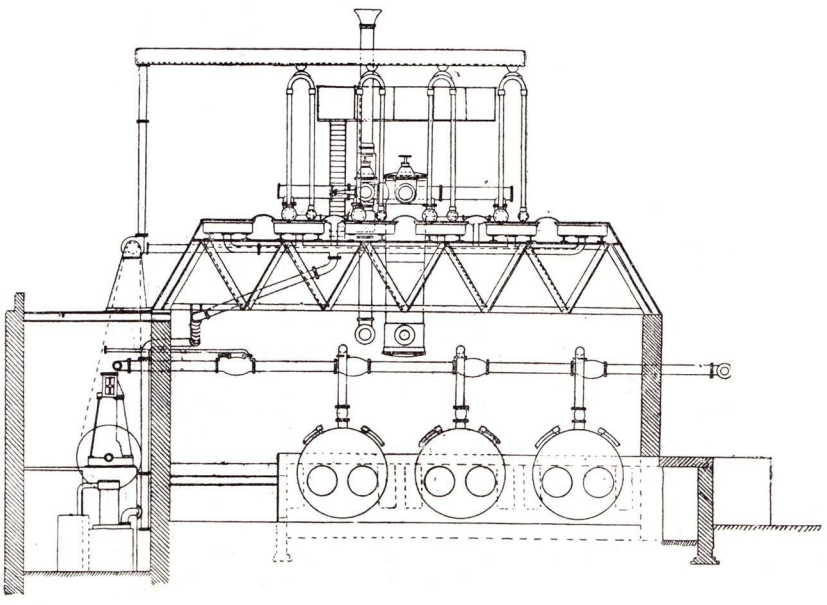
EVAPORATIVE CONDENSER
taking Steam from three sets of Mill Engines and working with one Air Pump.



THERMO CIRCULATOR, fitted to Marine or other Boiler for equalising temperature of bottom with top and preventing expansion strain.

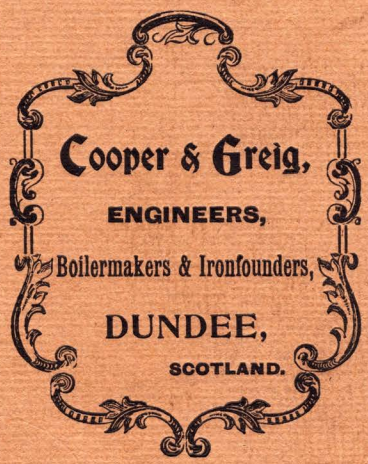


EVAPORATIVE CONDENSER
placed on top of factory roofing without disturbing same.



Cross Section of Electric Lighting Station showing our EVAPORATIVE CONDENSER with our Boilers, Valves, independent Air Pumps, and Piping.

J. P.
MATHEW & CO.
DUNDEE.


Cooper & Greig,
ENGINEERS,
Boilermakers & Ironfounders,
DUNDEE,
SCOTLAND.